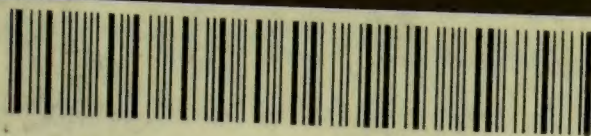


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A TEXT-BOOK OF SURGERY

BY

DR. HERMANN TILLMANN

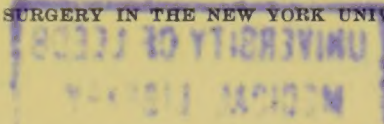
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EDITED BY LEWIS A. STIMSON, M.D.

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VOLUME III

REGIONAL SURGERY

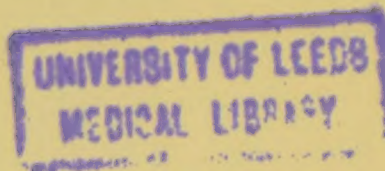
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TILLMANNS' REGIONAL SURGERY.

FIFTH SECTION.

SURGERY OF THE ABDOMEN.

CHAPTER XVI.

INJURIES AND DISEASES OF THE ABDOMINAL WALL.

Injuries.—Inflammatory processes.—Tumours of the abdominal wall (lipoma, sarcoma, fibroma, etc.).—Urachal cysts.—Echinococcus cysts.—Varicose veins of the abdominal wall.—Diseases of the umbilicus in infants and adults.

§ 151. **Injuries of the Abdominal Wall.**—Injuries of the abdominal wall are in part subcutaneous and in part open wounds. The latter may be *penetrating* or *non-penetrating*—that is, the peritoneal cavity may or may not be opened. It is of the greatest importance for the course of all injuries of the abdominal wall whether or not and to what extent the peritoneal cavity is opened. All *non-penetrating* wounds of the abdominal wall are to be regarded as slight injuries. If, on the contrary, the peritoneal cavity is opened and microbes gain an entrance, general peritonitis is to be feared, which, with rare exceptions, is fatal. Its most unfavourable form is diffuse septic peritonitis. Localized peritonitis, on the other hand, is much more favourable; by the aid of this form, as we shall see, injuries even of the stomach and the intestines may heal spontaneously.

Contusions of the Abdominal Wall, resulting from the action of blunt violence, are characterized by a corresponding extravasation of blood in the skin, in the subcutaneous cellular tissue, or in the muscle sheaths. These extravasations of blood usually spread downward and backward by gravitation, so that the characteristic dark-blue, greenish-black, and yellowish discolorations resulting from chemical changes in the hæmoglobin appear later on the back, in the hypogastrium, and even on the

thighs and the legs. These extravasations spread most rapidly and most extensively in the peritoneal connective tissue.

A rupture of the abdominal muscles sometimes occurs in connection with contusions of the abdominal wall, from lifting a heavy load or during parturition. Ruptures of the recti muscles are most common. Nussbaum saw two cases of rupture of the rectus muscle from coitus, and one case resulting from muscular contraction in connection with tetanus. In the course of acute febrile infectious diseases—typhoid fever, for example—subcutaneous ruptures may arise from violent contraction of the muscles, because the muscular fibres have become degenerated in consequence of the systemic intoxication and have lost their normal resistance. Among drunkards, also, the action of comparatively slight violence is sufficient to occasion rupture of the abdominal muscles. In the worst cases a rupture of all the layers of the abdominal wall occurs with prolapse of the viscera. Nussbaum observed this in the case of a drunken woman. Recovery took place after suture of the wound, but a recurrence followed, resulting in death. Rupture of the longissimus dorsi muscle has been observed as the result of lifting a heavy load. Patients usually experience intense pain at the moment of the rupture of the muscle. The objective examination reveals more or less extravasation of blood at the site of rupture. If this is made to disappear by massage, one can plainly feel the gap in the involved muscle in case the tear is a complete one. Subcutaneous ruptures always heal by the formation of a fibrous cicatrix, and this remains permanently, resembling one of the tendinous intersections. A regeneration at the site of rupture by the formation of new muscular fibres does not occur (see also *Principles of Surgery*, p. 468). In case the ends of the ruptured muscle are a considerable distance apart, the connective-tissue cicatrix may gradually become so stretched that a ventral hernia results, just as after laparotomy (see also *Hernia*). Suppuration occurs only exceptionally in subcutaneous injuries, when, for example, erysipelas spreads over the contused area from an open break in the skin or when the subcutaneous extravasation of blood becomes infected by microbes in the circulation in the course of an acute infectious disease, such as typhoid fever.

Ruptures of the abdominal organs, especially the liver, spleen, stomach, intestines, large vessels, bladder, etc., sometimes occur in severe contusions of the abdominal wall. For a description of these the reader is referred to § 155. The most dangerous of the subcutaneous injuries of the organs of the peritoneal cavity are ruptures of the large solid viscera, the vessels, the stomach, and the intestines. They prove fatal either from internal hæmorrhage or from escape of the contents of the

stomach and intestine with secondary general peritonitis. The escape of bile into the peritoneal cavity does not cause suppurative peritonitis, since it is aseptic, but it acts as a caustic upon the endothelium of the peritonæum, and thereby causes agglutinations and adhesions.

Shock following Contusions of the Abdomen.—After severe contusions of the abdominal wall, symptoms of shock varying in intensity are not infrequently observed. Shock in this case is conditioned upon a reflex alteration or paralysis of the vasomotor centre in the medulla which is caused by the contusion or concussion of the sensory nerves, and which can be produced in animals by the well-known Goltz experiment. By striking the belly of a frog a number of times a peculiar condition of collapse is brought about, in consequence of the mechanical irritation of the sensory nerves of the abdominal wall and viscera which gives rise to reflex changes in the vasomotor centre in the medulla. This condition of collapse may terminate fatally from paralysis of the heart in the diastole. The paralysis of the vasomotor centre in the medulla causes a diminution or paralysis of the vascular tone, particularly of the arteries, the circulation is slowed, a part of its impelling force being lost, and the blood pressure is lessened. The distribution of blood is uneven, the arteries are comparatively empty, the skin, lungs, and brain are anæmic, the blood collects in the veins, particularly those of the abdomen, and the right auricle is finally distended with it.

Persons suffering from shock after severe contusions of the abdomen show, therefore, a striking pallor and coldness of the skin and the visible mucous membranes. The face is pinched, the eyes lustreless and staring, the pupils are dilated and react slowly, the heart's action is slow and irregular, the pulse is thready, intermittent, and often not to be felt at all, and the respiration is likewise irregular, long and deep breaths alternating with superficial ones. The intellect is clouded and the patients are absolutely indifferent, and answer only slowly or reluctantly when repeatedly questioned. The sensibility of the skin and the energy of the muscular contractions are diminished. Nausea is not infrequently present, or the patient may vomit. The temperature of the body is usually from 1° to 1.5° C. ($1\frac{1}{2}^{\circ}$ to $2\frac{3}{8}^{\circ}$ F.) below normal. In addition to this torpid form of shock, an erethistic form has also been distinguished. In cases of the latter the patient is excited and uncontrollable, screams, and behaves sometimes like a maniac.

Patients recover, as a rule, sooner or later from the complex of symptoms attending shock which has just been briefly described. It is only in exceptional cases that shock goes on to coma and death from paralysis of the heart. The irritation of the terminal branches of the vagus nerve which is the inhibitory nerve of the heart also comes under consideration in connection with contusions of the abdominal wall and viscera.

The treatment of contusions of the abdominal wall conforms to general rules, as we have described them more in detail on page 504, *Principles of Surgery*. Massage is especially to be recommended (see *Principles of Surgery*, p. 505). In case of rupture of a muscle with considerable separation of its ends, suture of the muscle with catgut,

after dividing the cutaneous covering, is to be recommended, in order to prevent a ventral hernia. If a portion of a muscle has protruded through a rent in its sheath—the rectus, for example—and if this hernia of the muscle causes any disturbance, exposure and suture of the rent in the sheath are to be recommended (see *Principles of Surgery*, p. 509, *Hernia of Muscle*).

For the treatment of shock, see *Principles of Surgery*, § 63, p. 315.

Wounds of the Abdominal Wall.—Open wounds of the abdominal wall which do not penetrate into the peritoneal cavity are without special significance, if treated according to antiseptic rules. Divided muscles should be sutured with catgut. Of wounds of the blood-vessels of the abdominal wall, only those of the deep epigastric artery need be considered. This artery arises from the external iliac at about the middle of Poupart's ligament, runs obliquely upward and inward in the transversalis fascia and in the rectus muscle to the ensiform cartilage, and here anastomoses with the internal mammary. It also anastomoses with the superficial epigastric artery, with the intercostal, and with the lumbar arteries. On account of these numerous anastomoses, one must always tie both ends of the divided artery, as otherwise secondary hæmorrhages occur subsequently from the distal end, after establishment of the collateral circulation. Injury of the superficial epigastric artery, which arises from the femoral and ascends in the superficial fascia as far as the umbilicus, is without special importance. The same is true of wounds of the deep and superficial circumflex iliac arteries. Wounds of the lumbar arteries beneath the quadratus lumborum and erector spinæ muscles seldom occur except in the performance of colotomy and operations on the kidney.

Gunshot injuries of the abdominal wall are usually penetrating wounds, and we shall consider them more in detail in connection with injuries of the abdominal organs. Spent balls in particular may make non-perforating channels sometimes of considerable length, just as on the chest (see *Surgery of Thorax*, vol. ii, p. 671).

Any foreign body that may have entered the abdominal wall can be easily removed, as a rule, by an incision. They sometimes travel, needles especially, from the peritoneal cavity—e. g., from the stomach, the intestines, or from the vagina, and reach the abdominal wall, where they appear beneath the skin. It may be stated here as a matter of curiosity that Pétrequin, by incision in the neighbourhood of the umbilicus, extracted a uterine sound which had passed from the uterus into the abdominal wall. It had probably perforated the anterior wall of the cervix, then the vesico-uterine pouch, and had finally made its way to the umbilical region. The patient recovered.

§ 152. **Inflammatory Processes in the Abdominal Wall.**—Primary inflammation and suppuration in the abdominal wall take the form usually of a

lymphangitis, cellulitis, or erysipelas, following wounds of the abdominal wall which do not run an aseptic course. As the result of an extensive erythema, and particularly of a diffuse erysipelas of the abdominal wall, fatal hæmorrhages from the intestine have been known to occur in consequence of transitory hyperæmia of the same (Beyer, the author). I saw such severe hæmorrhage from the intestine, due to an extensive carbolic erythema following the use of the carbolic spray, that it caused the patient's death.

Secondary suppurations of the abdominal wall include the so-called cold abscesses following tubercular disease of the thorax (ribs, sternum) and of the spine. The spinal abscesses which follow tubercular inflammation of the vertebræ appear usually behind the quadratus lumborum muscle or in the region of Poupart's ligament, and also anteriorly in the linea alba. Abscesses of the lung and empyemata sometimes rupture into the abdominal wall. I have twice observed fistulæ of the lung in the posterior region of the abdomen with such a wide communication, in one case, that the air could be heard distinctly passing in and out during inspiration and expiration. Of other suppurative processes which involve the abdominal wall secondarily, I mention in particular abscesses of the liver, spleen, kidneys, and perinephritic connective tissue, and other abscesses of the peritoneal cavity—e. g., those following appendicitis, ulcers of the stomach and intestine, foreign bodies, etc., and, finally, those resulting from buboes, abscesses of the true pelvis following, for example, caries of the pelvis or the sacrum, from extensive hip disease, etc. Large abscesses are sometimes observed in the sheath of the rectus muscle near the umbilicus and in the space of Retzius; that is, in the space above and in front of the bladder filled with loose connective tissue—e. g., after injuries or in consequence of metastases. A fatal general septic peritonitis not infrequently results from perforation of these abscesses into the peritoneal cavity.

The treatment of these primary and secondary abscesses of the abdominal wall consists in their incision and drainage. Their cause is to be determined in each case, and the further treatment is to be governed accordingly.

For diseases of the umbilicus, see § 154.

§ 153. **Tumours of the Abdominal Wall** are not very common, and are in part void of special interest. They arise either in the skin or in the musculo-tendinous layers of the abdominal wall. Carcinomata and sebaceous cysts are occasionally observed in the skin, and especially lipomata in the subcutaneous cellular tissue. Primary carcinomata are rare. They are more frequently secondary, and result from adhesion of a carcinoma of the stomach with the abdominal wall. (For carcinomata of the umbilicus, see page 13.) Hernialike protrusions of the omentum, through a gap in the abdominal muscles or in the linea alba (epiplocele), are sometimes mistaken for lipomata, and hence, in making a diagnosis of lipoma, one should have such herniæ of the omentum in mind, particularly if an operation is contemplated. A continuation of the tumour into the peritoneal cavity in the form of a pedicle is a special indication of the presence of such an epiplocele,

and the latter can sometimes be wholly or partially reduced. Epiploceles are sometimes associated with dragging pains, which extend toward the place of insertion of the great omentum on the transverse colon. Those lipomata which arise in the properitoneal adipose tissue, and which in some cases likewise protrude through gaps in the abdominal muscles, are scarcely to be distinguished from epiploceles. Such properitoneal lipomata have also a special significance with reference to the development of herniæ, because they draw the peritonæum outward, and may thus gradually lead to the formation of a hernial sac. Properitoneal or retroperitoneal lipomata sometimes attain a considerable size (Madelung, *Homms*). The diffuse form of lipoma is also not infrequently observed, just as, for example, on the neck (see vol. ii, p. 557, Fig. 284).

The most frequent tumours of the abdominal wall are fibromata, fibro-myomata, and sarcomata, which originate usually in the inter-muscular connective tissue and in the fascia. The simple fibromata are by far the most common. Of seventy tumours of the abdominal wall, sixty, according to Säger, were simple fibromata. Fibromata of the abdominal wall usually grow slowly and develop most commonly in the region of the fossa or the crest of the ilium and in the sheath of the rectus muscle. The tumours are frequently adherent to the peritonæum, so that when they are extirpated a corresponding piece of the latter has to be removed at the same time. They sometimes reach an enormous size, and those especially of the lower abdominal region near the iliac fossa may easily be mistaken for tumours of the ovary or of the uterus. Weir removed successfully a fourteen-pound fibroma of the abdominal wall which had presented the appearance of an ovarian tumour. He was obliged to remove at the same time a large portion of the peritonæum. Fibromata of the abdominal wall occur much more frequently in women than in men. Of forty-one cases tabulated by Guerrier, thirty-eight were women and only three men. Ledderhose collected from literature one hundred cases, of which ninety were women and only ten were men. Of the ninety women, seventy at least had given birth to children, and it was mentioned in only two instances that such was not the case. The tumours occurred usually between the twentieth and thirtieth year, and developed most frequently after the puerperium in cicatrices in the tendinous and muscular portions of the abdominal wall. Some fibromata, especially fibro-myomata, originate inside the abdomen, and grow secondarily into the abdominal wall. Furthermore, sarcomata of the great omentum may become so intimately connected with the abdominal wall that they are mistaken for tumours of the latter.

The prognosis of sarcomata, fibromata, fibro-myomata, myxomata, and other mixed tumours of the abdominal wall is by no means unfavourable, in case the tumours are promptly removed before they have become adherent with too large a surface of the peritonæum. The more extensive the adhesions with the peritonæum, the greater the danger from the operation.

The extirpation of sarcomata and fibromata of the abdominal wall should be performed with the strictest observance of antiseptic precautions—the more so, because in case of larger tumours the peritoneal cavity usually has to be opened, inasmuch as the tumour is adherent to the peritonæum. The same precautions should be observed as in an intra-abdominal operation. Säger advises drawing the tumour forward and tying off the peritonæum, if necessary, like a tobacco pouch by a ligature *en masse*. If the tumour is adherent to a large surface of the peritonæum, one should remove the adherent peritonæum with the tumour, and then, after carefully arresting all hæmorrhage, close the abdominal wound without the co-operation of the peritonæum, it may be, by silver-wire—lead-plate sutures, interrupted sutures of heavy silk, and a continuous catgut suture, or by several rows of buried catgut sutures. In all cases in which the tumour can be successfully enucleated from the abdominal wall without opening the peritoneal cavity, the wound should be closed, after carefully arresting the hæmorrhage, by suture of the muscles and the skin, care being taken that no large cavity is left in the abdominal wall. The after-treatment is the same as that following laparotomy—that is, the wound is covered with a large aseptic dressing, especially if drainage is employed. If the wound is sewed up tight, as in an ordinary laparotomy, it is covered with sterilized gauze, over which sterilized absorbent cotton is laid, and the whole dressing secured by a few strips of adhesive plaster. Dressings of this kind are more agreeable to the patient than bandages or binders which encircle the body.

Urachal Cysts.—The urachus, as is well known, represents the obliterated portion of the allantois, and extends from the summit of the bladder to the umbilicus. Its thickness is very variable. Luschka, Hoffmann, and others were the first to show that the urachus very frequently does not become wholly obliterated. Cysts of the urachus were first described in detail by Luschka, Hoffmann, Wolff, and Roser. They may attain a considerable size, so that they are not infrequently mistaken for ovarian cysts, especially the so-called non-pedunculated ovarian cysts, which may sometimes be really urachal cysts. Hoffmann saw an enormous urachal cyst in a theological student twenty-six years of age. Seventy-five litres of fluid were drawn

from it within nine months by six different punctures. Urachal cysts are properitoneal, and lie in the median line. With increasing growth they break through into the peritoneal cavity, and sometimes become extensively adherent to the peritonæum and the neighbouring abdominal organs. Some of the cysts extend to the floor of the pelvis. They sometimes open through the umbilicus (urachal fistula), or communicate with the bladder through a small opening. Roser cured a urachal cyst that communicated with the bladder by introducing a catheter regularly every two hours into the bladder.

For the diagnosis of urachal cysts, their properitoneal location and slow growth are important. Upon abdominal section the parietal peritonæum is wanting. The origin of the tumour should be determined by careful bimanual examination through the vagina and rectum. Large numbers of pavement epithelial cells are often found in the fluid obtained by puncture. Urachal cysts are more common in men. Of fourteen cases tabulated by Stadfeldt, for instance, twelve were men and only two were women. The long, curved urethra of the male, and the comparatively frequent occurrence of phimosis, favour retention of urine in the bladder among boys, and this tends to keep the urachus open.

For urachal fistulæ see page 12 (Diseases of the Umbilicus).

The treatment of urachal cysts consists, above all, in their incision through the anterior abdominal wall, preferably in the linea alba, followed by drainage. Puncture of the cyst with or without the injection of iodine is usually unsuccessful. In suitable cases the complete extirpation of the cyst should be undertaken, but this is not possible, as a rule, in those which extend down to the floor of the pelvis. The latter are therefore best treated by drainage.

Echinococcus cysts of the abdominal wall are rare. They have been observed most commonly in the region of the urachus, so that it may be difficult to distinguish them from urachal cysts. The diagnosis may be established by an exploratory puncture and microscopic examination of the fluid obtained. Pronounced fluctuation or a wavelike impulse are usually present in connection with echinococcus cysts of the anterior abdominal wall, and there is sometimes a characteristic splashing sensation. Echinococcus cysts may, in some cases, be widely diffused in the abdominal wall.

The treatment consists in opening the cyst by a free incision, in drainage, and the application of an aseptic protective dressing. The cyst can sometimes be extirpated, and in other cases the sac gradually comes away in the course of the after-treatment.

Varicose veins of the abdominal wall and chest occur in rare cases from obstruction of the circulation in the vena cava, so that the venous blood then flows in part through the epigastric and internal mammary

veins. Billroth observed extensive varicose veins of the thoracic and abdominal walls in consequence of closure of the right innominate vein by a substernal carcinomatous goître. If the aorta is closed the collateral circulation takes place usually through the branches of the epigastric and internal mammary arteries.

§ 154. **Diseases of the Umbilicus in Infants and Adults.**—The pathological conditions which develop in connection with the omphalo-mesenteric duct will first be considered.

The umbilical cord, as is well known, contains in foetal life, aside from the umbilical arteries and veins, the urachus, which develops from the allantois and is a continuation of the bladder, and the omphalo-mesenteric or vitelline duct, which forms a connection between the ileum and the umbilical vesicle.

The omphalo-mesenteric duct usually becomes obliterated in the eighth foetal week and then disappears. Not infrequently, however, it persists in some form, generally as a blind sac communicating with the intestine (ileum), the so-called Meckel's diverticulum. In other cases a cordlike connection is found between the ileum and the inner surface of the umbilicus, or the intestine communicates with the umbilicus by a canal—that is, the omphalo-mesenteric duct has remained entirely open. In another category of cases cordlike remains of the vitelline duct are found only on the ileum or on the inner surface of the umbilicus. Cysts sometimes develop from the part of the vitelline duct which is not obliterated, and which is located in or behind the umbilicus or in the peritonæum (Vitelline Cysts, Roser, Zumwinkel).

The so-called Meckel's diverticulum is always found in the form of an intestinal appendage, attached somewhat obliquely to the lowest portion of the ileum, from one third of a metre to one and one third metres above the ileo-cæcal valve. It is from one or two to six inches long, and from half an inch to two inches in diameter. Sometimes, however, it has a greater diameter than the small intestine. It is usually of a cylindrical, a conical, or a knoblike form. At the junction of the diverticulum with the ileum there is often found a valve which Meckel interprets as an attempt at closure of the intestine. The diverticulum sometimes ends in a ligamentous cord or in several threads, which are either free in the peritoneal cavity or are adherent to the inner surface of the umbilicus, or to some other part of the peritonæum. In some cases the ligamentous cords and threads, or a pervious canal, do not pass from the inner surface of the umbilicus to the apex of the diverticulum, but directly to the mesentery. The true (Meckel's) diverticulum without connection with the abdominal wall occurs regularly in the coot, the snipe, and the swan (Cazin).

Those cases of Meckel's diverticulum are of special importance for the pathology of the umbilicus in which there exists in newborn infants a canal

filled with meconium, which runs from the umbilicus to the ileum. It either ends blindly at the umbilicus—that is, it is either closed here, or it passes through the umbilical ring into the umbilical cord, and, after the latter has been tied off or has separated, a faecal fistula is formed at the umbilicus. These umbilico-intestinal fistulae often heal spontaneously, especially when there is but a small communication with the intestine. In case of stricture or obliteration of the intestine below the diverticulum there naturally appear very violent symptoms of intestinal obstruction, with vomiting and tympanites, so that the formation of an artificial anus may become necessary. The mucous membrane of the umbilical fistula not infrequently prolapses more or less through the umbilical opening, and the diverticulum may be so everted that one finds at the umbilicus a red, hyperæmic tumour of mucous membrane as large as a cherry or a walnut, much as represented in Fig. 418, page 12. In such cases there is usually no open communication with the intestine. The probe reveals rather, as a rule, a blind fistula reaching a variable distance inward, or the everted diverticulum is completely closed. Such tumours, located at the umbilicus and covered with mucous membrane of the small intestine, and which do not communicate with the intestine, have been described particularly by Kolaczek, Küstner, Hickmann, Sadler, Chandelux, Rosthorn, Pernice, and others. They have also been designated as adenomata or teratomata, but the designation “prolapse of Meckel’s diverticulum” is more accurate. I do not question, of course, that adenomata and carcinomata may sometimes develop from such prolapses. The latter consist chiefly of an outer glandular layer, and then a layer of unstriped muscular fibres and connective tissue. Such tumours, resulting from the prolapse of a Meckel’s diverticulum, are most simply removed by dividing the pedicle with the galvano-cautery with or without ligation. If the diverticulum which has an open end at the umbilicus is in communication with the intestine—i. e., if there is a faecal fistula at this point—the prolapse of the mucous membrane may then, as in other faecal fistulae, become very marked, and large portions of the small intestine have then been seen to protrude through the umbilical opening (Siebold, Weinlechner, Gesenius, Hüttenbrenner, Basevi, A. Barth, and others). In case of other faecal fistulae of long standing, the prolapse affects either the upper or lower end of the intestine or both at the same time. In the case of “diverticulo-faecal fistulae” at the umbilicus it is always the portion of intestine located above the diverticulum that is prolapsed.

The treatment of such an inversion or invagination of the small intestine through an omphalo-mesenteric duct which has remained open at the umbilicus consists above all in reduction of the prolapsed mucous membrane with the oiled finger, or by means of a catheter enveloped in gauze, a female catheter, etc., after enlargement of the umbilical ring, if necessary, with the knife. After reduction, one must convince himself by the injection of lukewarm water whether the passage is really free, or the strangulation still persists within the diverticulum or the intestine. If the symptoms of strangulation continue, the obstruction should be removed by laparotomy, and possibly the formation of an artificial anus. If reduction of the invaginated intestine is altogether impossible, and there is no danger in delay, the prolapsed intestine may be allowed to become necrotic or may be cut away. If

an umbilico-faecal fistula does not close spontaneously or by cauterization with nitrate of silver, Paquelin's thermo-cautery, or the galvano-cautery, a radical operation should be performed—that is, the intestine or the diverticulum is detached at the umbilicus, the intestinal fistula freshened and sutured, and the intestine replaced in the peritoneal cavity. If there is a diverticulum it should be inverted and closed by suture or cut off close to the intestine, and the latter then sutured.

Other umbilico-faecal fistulae of newborn infants, which are not conditioned upon the presence of a Meckel's diverticulum, sometimes arise from the fact that an umbilical hernia of slight degree has been overlooked by the physician or the midwife, and that when the cord is tied an intestinal loop has either been tied off *in toto* or in part (Siebold, Dupuytren, Debout, and others). One should always carefully examine the cord, therefore, before it is tied, to determine whether or not there is an umbilical hernia—that is, whether or not a portion of intestine lies within the cord. If such a hernia is found, the portion of the intestine that lies in the umbilical cord should be completely reduced before the latter is tied. Umbilical herniæ may arise, according to Ahlfeld, like Meckel's diverticulum, from excessive or abnormally long-continued traction of the vitello-intestinal duct upon the intestine. As is well known, umbilical hernia in the first weeks of foetal life, up to about the beginning of the third month, is a physiological formation. From about the second to the tenth week after rupture of the vitello-intestinal duct the intestine recedes from the umbilical cord into the peritoneal cavity. Umbilical herniæ may also arise from abnormal adhesions of the viscera with one another or with the umbilical cord. The umbilical herniæ which develop later in foetal life and are usually smaller may also arise from the fact that by compression and malposition of the foetus within the uterus a peritoneal sac is formed at the umbilicus, into which intestine may enter (Cruveilhier, Scarpa).

Empty umbilico-hernial sacs which have been shut off sometimes give rise to the development of serous cysts of the umbilicus (Roser).

An umbilical hernia may, in rare cases, contain intestinal loops which have been completely tied off *in utero*, so that the intestine shows corresponding defects. In one case, for example, observed by Ahlfeld, there was found in an almost matured, well-developed infant, born six hours before, a tumour as large as an apple upon the side of the umbilicus, which was connected with the latter by a very small pedicle. The tumour was made up of intestine which had been tied off, and consisted of the lower portion of the ileum, the cæcum, and the ascending colon, with the corresponding portions of the mesentery.

For a more detailed description of umbilical herniæ and their treatment, the reader is referred to the chapter on hernia.

Umbilico-faecal fistulae in children and adults occasionally arise also from peritonitis, especially tubercular peritonitis. Ziehl, after two observations of faecal fistulae of the umbilicus resulting from tubercular peritonitis, collected from literature thirty analogous cases. Among the twenty cases observed in children, the fistula was situated eighteen times at the umbilicus and only twice in other parts of the abdomen.

Winiwarter described a faecal fistula of the umbilicus in a boy eight

months old, resulting from furunculosis, with subsequent phlegmonous infiltration of the abdominal wall in the vicinity of the umbilicus, followed by localized peritonitis.

Faecal fistulae are sometimes formed also after gangrene of the umbilicus resulting from inflammation of the umbilical vessels and the region of the umbilicus, in connection with catarrhal or croupous enteritis, and especially after wounds in the neighbourhood of the umbilicus, etc. Grawitz saw a well-marked faecal fistula of the umbilicus that had existed for thirty years, and was caused by a cut with a scythe. The defect in the abdominal wall was as large as the palm of the hand, and had the shape of an oval lying in the transverse diameter of the abdomen. Repeated attempts to close the fistula by operation had been unsuccessful.

In rare cases nematoids and other worms—the *tania solium*, for example—have passed off through the umbilicus or other parts of the abdominal wall (Siebold, Richter, Bottini, and others). In such cases there are usually coexisting ulcers of the intestine, and after adhesion of the latter to the abdominal wall a circumscribed abscess is formed.

In very rare cases biliary fistulae have been seen in the region of the umbilicus, in consequence, for example, of chronic inflammation of the gall bladder, abscess of the liver, echinococcus, etc. (Lequelin).

Urachal fistulae resulting from the remaining open of the urachus, with discharge of urine through the umbilicus, have been repeatedly seen. Rokitsky, Roger, Goldschmidt, and others have observed urinary calculi in the urachus. Paget extracted a vesical calculus from the urachus through the umbilicus. A prolapse of the mucous membrane of the urachus sometimes occurs here also. Urachal fistulae of the umbilicus which are not congenital are very rare (Larrey, Worster, Jacoby, Cadell, Paget, Bryant, T. Smith, Bramann). The patient has usually had bladder trouble of long standing, and the urachus generally opens at the umbilicus during an acute or chronic

cystitis. Such fistulae have been closed without difficulty by freshening and suturing them, by cauterization with Paquelin's thermo-cautery or the galvano-cautery, and also by tying off the prolapsed mucous membrane.

We have already spoken of urachal cysts, pages 7 and 8.

Umbilico-gastric fistulae sometimes develop in connection with a carcinoma or ulcer of the stomach that is adherent to the abdominal wall.

I saw congenital prolapse of the mucous membrane of the stomach through the umbilicus in a boy thirteen years of age (see *Deutsche Zeitschrift für Chirurgie*, Band xviii). So far as I know, no similar observation had ever

been reported. A pedunculated tumour as large as a walnut, and covered with mucous membrane, was found at the umbilicus (see Fig. 418), just as in prolapse of Meckel's diverticulum described on page 10. Digestive experiments with the secretion of the mucous membrane of the tumour and the

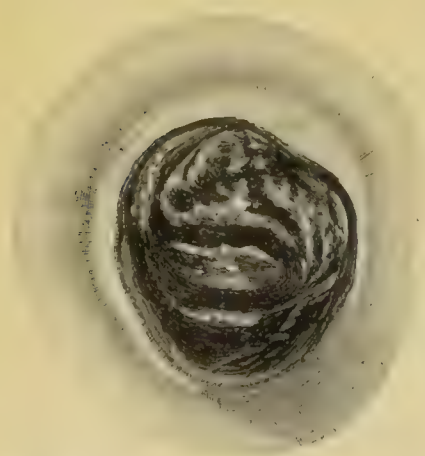


FIG. 418.—Prolapse of the mucous membrane of the stomach through the umbilical ring.

microscopic examination of the latter proved that it was a case of congenital prolapse of the mucous membrane of the stomach. Communication with the stomach no longer existed. The secretion of the tumour was rather abundant. Its pedicle was severed with the knife, and the hæmorrhage arrested by Paquelin's fistula cautery. There had probably been in this case an umbilical her-

nia containing a diverticulum of the stomach as represented diagrammatically in Fig. 419. After the birth of the child the diverticulum of the stomach was tied off with the umbilical cord, and a prolapse of the mu-

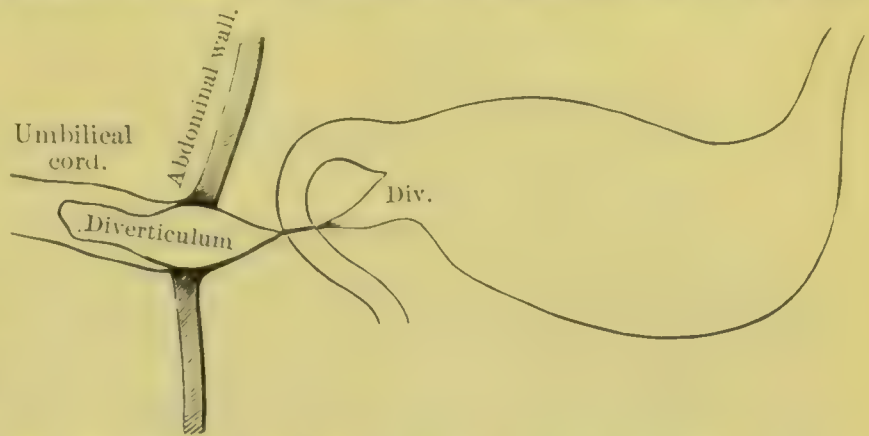


FIG. 419.—Origin of prolapse of the mucous membrane of the stomach through the umbilical ring (diagrammatic).

cous membrane of this diverticulum developed later, which was open at the umbilicus but closed in the direction of the stomach.

Siegenbeck and Rosthorn, who observed an analogous case, believe that we have to do with a diverticulum of the intestine which has been tied off at an early date, is lined with pseudo-pylorus epithelium, and has an acid secretion. If the separation from the intestinal tract follows at a later period, the mucous membrane of the umbilical fistula contains Lieberkühn's cysts and goblet cells, and has an alkaline secretion.

In case of non-aseptic treatment of the umbilicus after separation of the cord, phlebitis, with suppurative breaking down of the thrombi, may occur and extend as far as the liver, with secondary abscess of the latter. Other diseases also that arise from wound infection can originate in the umbilical wound if the rules of antisepsis are neglected. Tetanus has been observed in some instances after infection of the umbilical wound by the tetanus bacillus.

Tumours of the umbilicus are rare (Küster). Aside from urachal cysts, which were mentioned on pages 7 and 8, there have been seen especially lipomata, fibromata, fibro-lipomata, angeiomata, myxomata, sarcomata, fibro-sarcomata, dermoid cysts, sebaceous cysts, papillomata, and epitheliomata. I saw an extremely malignant carcinoma of the umbilicus, leading rapidly to secondary carcinoma of the liver, in a man of fifty-six, which developed after a blow. Roser and Zumwinkel described a vitelline cyst in the peritonæum near the umbilicus (see page 9), and Wyss a ciliated cyst. Empty hernial sacs which have been shut off, whether congenital or acquired, give rise to the formation of serous cysts.

The so-called granulomata resulting from proliferation of the granulations after separation of the umbilical cord are best removed by the galvano-caustic needle or by Paquelin's fistula cautery.

CHAPTER XVII.

INJURIES AND DISEASES OF THE PERITONEAL CAVITY.

Subcutaneous injuries of the abdominal organs.—Penetrating wounds of the abdomen, with injury of the abdominal organs.—Ligation of the abdominal aorta, the common iliac, the internal iliac (hypogastric), and the external iliac arteries.—Embolism or thrombosis at the bifurcation of the aorta, with thrombosis of the common iliac artery.—Peritonitis.—Tuberculosis and tumours of the peritonæum.—Retroperitoneal tumours.—Puncture and incision of the peritoneal cavity (laparotomy).—Extraperitoneal laparotomy.

§ 155. **Subcutaneous Injuries of the Abdominal Organs.**—Injuries of the abdominal cavity are in part subcutaneous, without opening of the cavity, caused by severe contusions, and in part open wounds of the cavity. In either case the abdominal viscera may or may not be injured. We shall occupy ourselves first with subcutaneous injuries of the peritoneal cavity or its organs. Subcutaneous injuries, such as rupture of abdominal viscera of varying degree, occur usually from a blow or a fall upon the abdomen, from being kicked by a horse, from being run over, from being buried up, from being crushed between the buffers of two railway carriages, etc. Ruptures of the stomach and the intestines may result from all these injuries, especially if these organs are more or less filled with food or distended with gas; or ruptures of varying depth of the liver, the spleen, and the large abdominal vessels may occur. The bladder may also be ruptured in the same way, and this is more likely to happen if it is filled with urine. If the spleen is very full of blood and much enlarged, even slight violence, such as vomiting or difficult labour, is sufficient to cause a rupture of the parenchyma. Injuries of the abdominal organs may arise from indirect violence also, such as severe concussion of the body resulting from a fall from a great height upon the pelvis, the knee, etc. The degree to which the gastro-intestinal canal is filled at the time is also of great importance as regards rupture from indirect violence. I saw rupture of the duodenum occur in a boy of fourteen years who was lifted up by the axillæ and tossed about immediately after eating.

Ruptures of the stomach from contusions of the abdomen are

found most frequently in the region of the pylorus and the greater curvature. In case of pathological changes or ulceration of the stomach, rupture may result even from vomiting, especially in the region of the cardia and at the lower end of the œsophagus (see vol. ii, p. 535). In the so-called spontaneous rupture of the stomach there is usually a gastric ulcer or a primary hæmorrhage with secondary softening, or it may be a post-mortem rupture. Injuries of the stomach sometimes occur from careless lavage of the same (see § 165).

Ruptures of the intestine from contusions of the abdomen are observed most frequently, according to Poland, at the lower end of the duodenum and at the duodeno-jejunal flexure. The lower portion of the duodenum is fixed by the suspensory muscle of the duodenum, which was discovered and described by Treitz, and consists of un-striped muscular fibres. This triangular muscular band has a broad attachment at the upper border of the duodenum, and passes upward in the form of a cord to the aortic opening in the diaphragm, where it is continuous with the muscular fibres of the latter.

Ruptures of the small intestine are more frequent than those of the large intestine, which is more elastic and has thicker walls. The fixed parts of the latter also, especially the flexures, are most endangered in case of direct and indirect contusions of the abdomen.

Ruptures of the intestine may also arise from overdistention with fæces and gas caused by intestinal obstruction, due, for example, to carcinoma, compression of the intestines by tumours or so-called internal strangulation. Perforations of the intestine sometimes result from erosion of the same by traumatic or non-traumatic suppuration in the vicinity, by abscesses of the liver, the spleen or the kidneys, or by tumours which break through into the intestine, etc.

The course of a rupture of the gastro-intestinal canal naturally depends upon whether or not the rent involves the entire wall, and also whether or not and to what extent the contents of the canal escape into the peritoneal cavity. If the rupture is a complete one, general septic peritonitis with a speedy fatal termination usually results. In favourable cases the gastro-intestinal contents which have escaped into the peritoneal cavity become encapsulated by adhesions between the coils of intestine, and a circumscribed abscess results. After this has broken through externally or into the intestine, or after incision of the same, complete recovery may follow.

The outcome of a subcutaneous rupture of the omentum depends mainly upon the number and size of the ruptured blood-vessels. Death may ensue from internal hæmorrhage.

Among subcutaneous injuries of the abdominal viscera ruptures of

the liver are the most frequent. In ruptures of the liver, the spleen, and the kidneys, the further course depends chiefly upon the degree or depth of the tear and the amount of hæmorrhage. Death not infrequently follows from internal hæmorrhage. Injuries of the larger bile ducts and of the gall bladder also come into consideration in connection with ruptures of the liver. General peritonitis does not occur, however, from the escape of bile into the peritoneal cavity. On the contrary, bile is not only aseptic, but it also possesses, according to Gmelin, Tiedemann, Bidder, Schmidt, and Kossel, antiseptic qualities, inasmuch as it prevents or diminishes, for example, the process of putrefaction within the intestines. It is, however, more or less irritating to the endothelium of the peritonæum, so that it may give rise to agglutination of the peritoneal surfaces. Patients with a biliary fistula opening into the peritoneal cavity, if not operated upon, finally die of jaundice with increasing marasmus. Lane saw a case of rupture of the gall bladder in which there was a large amount of bile in the peritoneal cavity for five weeks and only a moderate serous exudation. The patient was cured by an operation. Landerer, in a case of injury of the bile ducts, aspirated five times in the course of twenty-nine days, and obtained twenty-seven litres of fluid composed of bile, serum, and mucus. The injury of the bile ducts then healed spontaneously. Contusions of the liver are sometimes followed by parenchymatous hæmorrhages which may lead to a progressive interstitial proliferation of connective tissue, to a traumatic cirrhosis. Fatal hæmorrhage sometimes results from ruptures of the spleen and the kidneys, especially when the large vessels of these organs are torn at the hilum. As regards subcutaneous injuries of the kidney, those due to indirect violence—from a fall, for example—give rise to ruptures at the hilum, while direct contusions usually cause irregular ruptures on the anterior surface of the organ (Maas, Edler, Grawitz, W. Herzog). Of ninety-two cases of subcutaneous injury of the kidney, sixty, according to W. Herzog, ended in recovery and thirty-two ended fatally. Of one hundred and forty-one patients, seventy-five, according to Bobroff, recovered and sixty-six died (see also § 156, pages 19–25). Parenchymatous hæmorrhage from the liver, spleen, and kidney ceases spontaneously if large vessels are not injured, as I have shown by experiments upon rabbits. Retention of urine may ensue after ruptures of the kidney from the accumulation of blood clots in the ureter, in the bladder, and in the urethra. If the kidneys are diseased, death from uræmia may occur in case of very extensive injury of one kidney, and in the same way of a so-called horseshoe kidney (see Surgery of the Kidney). Stone formation sometimes follows hæmorrhage from

the kidney, both in the kidney as well as in the bladder. We shall return to this later under the subject of vesical and renal calculi.

Nephritic and perinephritic abscesses are very rarely the result of subcutaneous injuries of the kidney. They are caused by microbic infection from the bladder, ureter, or pelvis of the kidney—e. g., in connection with inflammations of these organs or by infection through the blood. Subcutaneous injuries of the spleen and the liver are likewise followed by suppuration only when the extravasated blood is infected by microbes within the blood. Regarding injuries of the pancreas the reader is referred to *Surgery of the Pancreas*, § 163.

Traumatic ruptures of the ureters need special mention. They are characterized by severe febrile disturbances, the formation of a tumour in the surrounding cellular tissue which contains urine (pseudo-hydronephrosis—see *Hydronephrosis*), by slight or no admixture of blood with the urine, and by a diminished amount of urine. Depending upon the size of the rupture, a retroperitoneal extravasation may form either slowly or rapidly, and the amount of extravasation determines the degree of obstruction to the flow of urine from the kidney. In case the ureter is crushed and afterward perforated, the extravasation is not formed until later. Complete rupture of both ureters is followed in a few days by death, with the signs of anuria. The treatment of ruptures of the ureter consists, in case of the formation of an extravasation, in incision and drainage of the lumbar or renal region. In case there are suppuration and fever, or complete obstruction to the flow of urine from the kidney, nephrectomy may be indicated. It is but rarely possible to close the tear in the ureter by sutures. A resulting fistula of the ureter may be treated by exposure and suture of the fistula, by nephrectomy, by implantation of the proximal end of the ureter into the bladder (Büding-*er*), into the intestine (large intestine, Chaput), or into the rectum (Novaro, Küster). The end of the ureter should be ingrafted in an oblique direction just as in Witzel's gastrostomy. In suturing together the ends of the divided ureter the best plan is to close the distal end by a ligature, then invaginate the central end into a slit in the distal end, and suture it here (ureterostomy, Hook, Bloodgood, Fenger).

We have already spoken of injuries of the diaphragm caused by severe contusions (vol. ii, § 124, p. 691).

We shall speak more in detail of subcutaneous ruptures of the bladder under surgery of the urinary organs (§ 207). Only the following brief statement need be made here: Subcutaneous ruptures of the bladder occur especially when the bladder is filled, and the rent is usually intraperitoneal on the posterior wall. It is sometimes, however, extraperitoneal on the anterior wall, with escape of urine into the pre-vesical space of Retzius. An extraperitoneal extravasation of urine is always more favourable than an intraperitoneal. Of ninety-seven cases of intraperitoneal extravasation, only one, according to Maltrait, was

cured by laparotomy, whereas of seventy-six cases of extraperitoneal rupture of the bladder, twenty-nine recovered. In case the bladder is empty, the edges of an intraperitoneal rent may in exceptional cases adhere so quickly that no urine enters the peritoneal cavity. If the urine is aseptic, peritonitis does not develop immediately, but the urine is quickly decomposed and infection usually occurs from within the urethra or by a catheter, and general peritonitis consequently ensues within a few days. In case of extraperitoneal rupture of the anterior wall of the bladder a corresponding swelling appears in the anterior abdominal region above the symphysis. The most important symptoms of a subcutaneous rupture of the bladder are hæmorrhage, emptiness of the bladder, especially in case of a large intraperitoneal rent, with escape of the urine into the peritoneal cavity, and septic peritonitis or a septic perivesical phlegmon resulting from extravasation of urine and infection from the urethra or by a catheter. Ruptures of the bladder are not infrequently complicated by fracture of the pelvis.

The symptoms of subcutaneous injuries of the abdomen resulting from severe direct or indirect contusions consist in more or less marked manifestations of shock, followed by signs of injury of certain abdominal organs. We have already described the symptoms of shock and contusions of the abdomen on pages 1-3, and mentioned that death may occur in rare cases in consequence of the former, even though the abdominal organs are not injured. The symptoms following injury of the abdominal viscera from severe contusions of the abdomen are often very indefinite at first, so that the decision whether any and, if so, what organs are injured is difficult or impossible. It is a well-known fact that even persons with rupture of the intestine and escape of its contents into the peritoneal cavity have sometimes walked a considerable distance. Pain and inflammatory symptoms may in cases of rupture of the intestine be surprisingly slight for the first few hours after the injury, and still death may follow within twenty-four hours, from increasing collapse. In other cases the course is slower. General peritonitis develops, which causes death after several days unless an attempt is made to save the patient by laparotomy.

The special symptoms consequent upon injury of the abdominal organs depend naturally upon the organ injured. The patient dies, aside from shock, either very soon after the injury in consequence of internal hæmorrhage, or within forty-eight hours usually as the result of general peritonitis from the escape of gastro-intestinal contents or urine into the peritoneal cavity. In every case of severe contusion of the abdomen a careful examination by palpation and percussion should be undertaken and special stress laid upon the location of any tumour

that may exist, any localized pain, the vomiting of blood, bloody stools, bloody urine, etc. Possible associated injuries should always be borne in mind. The symptoms of general septic peritonitis resulting from rupture of the stomach, intestine, bladder, etc., are chiefly gaseous distention of the abdomen (tympanites), severe pain, vomiting, fever, with a thready pulse and inclination to collapse, etc. (see § 158, p. 34 ff., Peritonitis).

To avoid repetition, the reader is referred for the symptomatology and the course of injuries of special organs to § 156 (Wounds of the Abdominal Organs).

The treatment of subcutaneous injuries of the abdominal organs is essentially the same as that of open wounds, and the reader is therefore referred to § 156. In all cases of severe contusions of the abdomen in which injury of the abdominal organs can not be definitely made out during the first hours after the accident, the peristalsis of the intestines should be diminished by large doses of opium. If it is certain that an organ of the peritoneal cavity has been injured, if there are indications of internal hæmorrhage and beginning peritonitis, laparotomy should be performed, the injured organ found as quickly as possible, and the necessary measures adopted depending on what is found—that is, the hæmorrhage arrested, the ruptured stomach, intestine, or bladder sutured, the peritoneal cavity drained, etc. In case of subcutaneous injury of a kidney it may be necessary to expose the injured organ promptly from behind by means of a longitudinal or transverse incision (see Nephrectomy) and to arrest the hæmorrhage or resect or remove the organ. The treatment of shock has been given in Principles of Surgery, § 63, p. 315.

§ 156. **Wounds of the Peritoneal Cavity.**—Wounds of the peritoneal cavity consist either in mere perforation of the same, without injury of the abdominal organs, or the latter may be likewise wounded.

Wounds of the peritoneal cavity without injury of the abdominal organs are always, of course, more favourable than those in which viscera are likewise involved. Complete perforations even of the peritoneal cavity by a sword, a lance, or a bullet have occurred, in exceptional cases, without injury to the abdominal organs. MacCormac mentions the following case: In the American civil war an escaping prisoner was stabbed through the body with a bayonet in such a way that the point of the latter, which had entered in the left iliac region, projected posteriorly two inches from the spine. The wound healed on the fourth day. It is still possible that the abdominal organs, especially the intestines, were injured, but that, owing to the immediate formation of peritoneal adhesions, no symptoms appeared. Hennen

saw a case in which a ramrod perforated the peritoneal cavity without injuring any viscera. In gunshot wounds it is only in very rare cases that the abdominal organs remain unharmed. The most common injury is that of the intestines. Larrey, in his long period of service, saw but one case in which a ball which perforated the abdomen did not immediately cause serious disturbances. Beck, on the other hand, who was with Werder's army in the Franco-Prussian War, saw seven gunshot wounds of the abdomen in which there was no ground for suspecting injury of the abdominal organs. In five of these cases recovery followed without incident.

If the abdominal wall is extensively opened, prolapse of the intestines is likely to occur. Ventral herniæ after laparotomy have some-

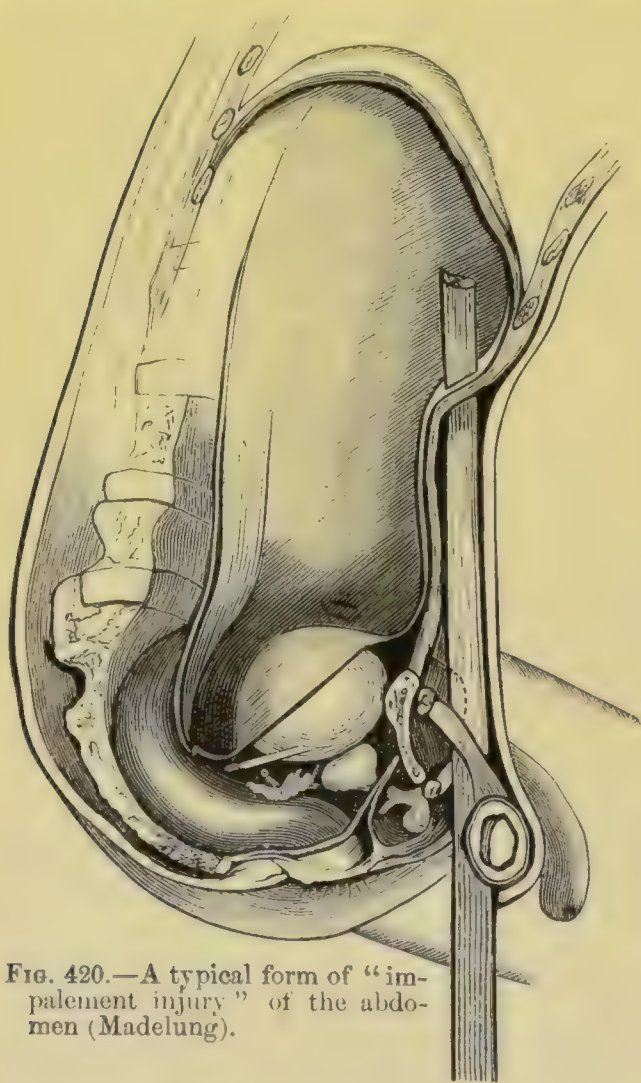


FIG. 420.—A typical form of "impalement injury" of the abdomen (Madelung).

times so thin a cutaneous covering that they tear open in consequence of comparatively slight injuries and occasion prolapse of the small intestine. A case of this kind was recently seen in Thiersch's clinic.

Injuries of the abdomen are frequently caused by a fall upon a blunt or a bluntly pointed stake. A typical form of this impalement injury of the abdomen through the perinæum or the scrotum, which Madelung recently observed in two cases, is shown in Fig. 420. If a person falls from a considerable height, striking in the perineal region upon a firmly fixed perpendicular stake, the latter, in case it does not glide off in the direction of the back

or enter the rectum, will move forward along the tense skin of the perinæum to the scrotum. The point of the stake then passes through the latter, between the anterior surface of the os pubis and the spermatic cord, then between the peritonæum and the abdominal muscles as far as the free border of the ribs, and, after perforation of the muscles and the peritonæum, enters for the first time the abdominal

cavity and leads to injuries of the stomach, liver, spleen, and diaphragm (Fig. 420). Even when it is certain that a stake has passed through the scrotum into the abdomen to the depth of a foot, the prognosis is not necessarily hopeless if only such scrotal wounds are carefully examined and the wound channel followed to its end.

Wounds of the peritoneal cavity with injury of the abdominal organs occur, in time of peace, especially from stabs with a knife resulting from quarrels, and in time of war, from the sabre, the bayonet, or the spear, or from gunshot injuries. Gunshot wounds of the abdomen, which occur not infrequently in time of peace also, are the most dangerous injuries. About one tenth of all who fall in battle die, according to MacCormac, from being shot in the abdomen, but only three or four per cent of the cases come under treatment.

Wounds of the intestines are the most common, especially those of the small intestine, and of the latter the ileum is most frequently and the duodenum least frequently injured. The intestine may be perforated in several places. Longmore saw a case in which one ball caused sixteen intestinal perforations. The ball sometimes remains within the intestine or the stomach, and then passes off with the *fæces per rectum*. Wounds of the large intestine are not so dangerous, generally speaking, as those of the small intestine, because the former is only partially covered by peritonæum, and the *fæces* that escape sometimes lead to an extraperitoneal *fæcal* abscess. Recoveries have most frequently been seen to follow wounds of the *cæcum* and the ascending colon, then those of the descending colon and the lower portion of the rectum.

General septic peritonitis, which is promptly fatal, usually develops after the escape of intestinal contents into the peritoneal cavity. Recovery is possible in cases of intraperitoneal perforation of the intestines only when the wound is closed by adhesions between the neighbouring loops of intestine or with the abdominal wall, or the peritonitis leads to the formation of a circumscribed abscess and this is shut off on all sides from the rest of the peritoneal cavity, or when the intestine is sutured as soon as possible after the injury.

Wounds of the stomach usually lead to a speedy death in consequence of the escape of the contents of the stomach into the peritoneal cavity, followed by general septic peritonitis. The mortality of wounds of the stomach is very high. MacCormac gives it as ninety-nine per cent. The location and direction of the wound are of great importance in their bearing upon the prognosis of a wound of the stomach. The principal symptoms are shock, vomiting of blood, and severe pain in the region of the stomach. Wounds occurring when

the stomach is empty are the most favourable. If the stomach is full at the time of the injury, the escape of its contents, with subsequent general peritonitis which is quickly fatal, is the rule. It is only rarely that this unfavourable termination is prevented by adhesion of the wound in the stomach with the abdominal wall and with the neighbouring coils of intestine. I cured a perforated ulcer of the stomach the size of a three-mark piece, which was adherent to the abdominal wall, by laparotomy and suture of the stomach (gastrorrhaphy). MacCormac saw the stomach of a man who had received a gunshot wound two years before his death, and then died of cholera. The cicatrices, which were distinctly visible, showed that the ball had perforated the posterior and anterior walls of the stomach. Larrey saw recovery after a sabre wound of the stomach. Archer observed recovery follow a wound of the stomach two inches long in spite of the escape of the contents of the stomach into the peritoneal cavity. Particles of food were still found in an abscess in the iliac region. Wounds of the stomach were also repeatedly cured by suture even before the adoption of antiseptic methods.

If a wound of the stomach or intestine leads to a circumscribed abscess, this may rupture externally, or through the diaphragm into the pleural cavity, the lung, or the pericardium, as we have already mentioned (§ 124). The abscesses which point toward the thoracic cavity usually lead at first to a so-called subphrenic pyopneumothorax, to a subphrenic fæcal abscess. Even fæcal abscesses in the neighbourhood of the cæcum can also in time break through the diaphragm into the thoracic cavity. I cured by thoracotomy a case of thoracic fæcal fistula after probable perforation of the duodenum. Permanent gastric and intestinal fistulæ may arise from the external perforation of such abscesses resulting from injuries of the stomach and intestine.

Adhesions between the coils of intestine may result in intestinal obstruction so that the formation of an artificial anus becomes necessary.

Wounds of the omentum are sometimes very extensive, especially those arising from a contusion or gunshot injury, and the hæmorrhage may be marked. Generally speaking, however, wounds of the omentum are not dangerous. The nutrition of the stomach and intestines is endangered only when large portions of the omentum are destroyed. The nutrition of the intestines may, in the same way, be affected in consequence of large wounds of the mesentery.

Wounds of the liver, in case the injuries are deep, usually terminate fatally from hæmorrhage. If a wedge-shaped piece is excised from the edge and the upper surface of the liver of rabbits, the hæmorrhage

is arrested spontaneously, even though the wound be not closed by suture. I saw a favourable result follow the tearing out of a pedunculated piece of the liver. Aside from stabs with a knife, a spear, a bayonet, etc., wounds of the liver arise often from gunshot injuries, from penetration of the liver by fragments of the ribs, from fractures of the spine, etc. Jaundice is always present in case of deep wounds of the liver. Wounds of the gall bladder and the main bile ducts with escape of bile into the peritoneal cavity, as mentioned on pages 16 and 17, are not in themselves fatal. In some cases a permanent biliary fistula is formed with marked jaundice which may lead, by increasing marasmus, to a fatal termination if the biliary fistula is not cured spontaneously or by an operation. If fatal hæmorrhage does not take place in wounds of the liver and if the wound remains aseptic, recovery follows. MacCormac mentions ten recoveries after gunshot wounds of the liver. Of 543 cases of injury of the liver, 180, according to Edler, recovered and 363 ended fatally.

Little that is reliable is known about wounds of the pancreas. They occur very seldom alone. Of thirteen wounds of the pancreas, seven, according to Edler, proved fatal and six recovered. We shall take up the surgery of the pancreas more in detail in § 163.

Wounds of the spleen are especially dangerous on account of the severe hæmorrhage which usually ensues, if the wound is extensive and deep. Of 160 cases of injury to the spleen, 47, according to Edler, terminated in recovery and 113 ended fatally. Prolapse of the injured or uninjured spleen through the abdominal wound is not infrequently observed.

Wounds of the kidney, like those of the liver and the spleen, usually give rise to severe hæmorrhage. One can, however, cut from the kidney of a rabbit deep, wedge-shaped pieces reaching through the entire cortical substance into the pelvis of the kidney without causing death from bleeding. The hæmorrhage is usually arrested spontaneously without suture of the wound. In the American civil war twenty-six recoveries from gunshot wounds of the kidney were observed. Injuries of the kidney have recently been studied in detail, both experimentally and clinically, especially by Grawitz, Tuffier, Edler, Barth, and others. Of 108 cases of subcutaneous injuries of the kidney, 58, according to Grawitz, recovered (see also page 16). Grawitz estimates the mortality of subcutaneous uncomplicated injuries of the kidney at 31·5 per cent. The course of a wound of the kidney depends upon any complicating injuries of other organs that may exist, upon the amount of hæmorrhage, and upon whether or not infection or suppuration ensues (see also page 16). The ureters are not infrequently in-

jured in laparotomies. Regarding the healing of wounds of the kidney, see § 203.

The most dangerous wounds of the liver, the spleen, and the kidney are those which are associated with injury of the large vessels at the hilum.

Death from hæmorrhage usually follows immediately in cases of injury of the large vessels of the abdomen, the abdominal aorta, the inferior vena cava, the iliac arteries, etc., or the hæmorrhage is arrested temporarily and severe secondary hæmorrhage ensues, which results fatally. The fact of the injury of the large vessels of the abdomen that have been named is usually first established at the autopsy. In the American civil war only fifty-four cases of gunshot wounds of the abdominal vessels came under hospital treatment, according to Nussbaum, and of these patients, forty-seven died very soon. It is only by some fortunate chance that such patients can be saved. The wounded man usually falls to the ground and dies almost immediately.

In wounds of the bladder the infection of the perivesical extravasation of urine is especially to be feared, particularly in case of intra-peritoneal injuries. We shall return to wounds of the bladder when dealing with the surgery of the genito-urinary organs (see § 207).

For the diagnosis of an injury of the abdominal organs, the location and direction of the external wound are of especial importance, as well as any intra-abdominal collection of blood that may exist, the passage of blood *per rectum*, the vomiting of blood in injuries of the stomach, etc., as already described in speaking of contusions and ruptures of the abdominal organs (§ 155, page 14 ff.).

Treatment of Abdominal Injuries.—In case of penetrating wounds without injury of abdominal viscera, the wound in the abdominal wall should be carefully disinfected with a 1-to-1,000 solution of bichloride or a three-per-cent solution of carbolic acid, and then, as after laparotomy, sutures inserted that pass through the entire thickness of the wall, so that the parietal peritonæum may be brought into as close contact as possible. Lead-plate—silver-wire—sutures (see Principles of Surgery, p. 108) and interrupted silk sutures are the best. The edges of the skin are best brought into exact coaptation by means of a continuous suture of fine catgut. It is also a very good plan to suture the peritonæum, fascia, muscles, and skin separately with silk or catgut (see § 159, page 47).

It is often uncertain whether or not an already agglutinated wound communicates with the peritoneal cavity. Should one, in such cases, determine this point by means of the probe? Opinions differ regarding the answer to this question. It is certainly very important to

know whether a wound has penetrated into the peritoneal cavity or not; and inasmuch as my probe is surely aseptic, I always use it, and do not wait to see whether or not aseptic healing follows by primary union. Every non-penetrating wound of the abdominal wall must also be carefully disinfected with 1-to-1,000 bichloride.

If intestine or omentum has prolapsed through the wound in the abdominal wall, it must likewise be carefully disinfected and returned inside the abdomen. In case the omentum is too severely contused, it should be tied off in sections with aseptic catgut and cut away with scissors. The chief danger in such cases consists in the reposition of prolapsed intestine that has not been sufficiently disinfected, and I agree with Krönlein when he says that first aid, consisting in returning prolapsed intestine, often causes the death of the injured person; it is far better to leave such patients untouched and merely protect the wound temporarily, and send them at once to the nearest hospital. It is also possible that wounded intestine may have been returned inside the abdomen.

If an aseptic course free from fever should not follow a penetrating injury of the peritoneal cavity, but general peritonitis develops, laparotomy should be performed as quickly as possible, for the additional reason that one may perhaps have overlooked an injury of an abdominal organ, especially of the stomach, the intestines, or the bladder. After opening the peritoneal cavity, it should be dried as thoroughly as possible by the use of aseptic sponges, gauze pads, compresses, etc., the abdominal wound drained, and the patient kept on his stomach or side to facilitate drainage. In case of a female patient, the peritoneal cavity may be drained through Douglas's pouch.

Laparotomy is the surest means of securing recovery in cases of penetrating wounds of the peritoneal cavity with perforation of the stomach, the intestines, the large abdominal vessels, and other abdominal organs. Particularly in cases of injury of the stomach, the intestines, or the bladder, and in case of fresh internal hæmorrhage, one should expose the injured organ as quickly as possible after the accident by opening the peritoneal cavity, and then proceed according to the condition of things that is found—that is, ligate the injured vessels, arrest parenchymatous hæmorrhage by means of the thermo-cautery, extirpate in suitable cases a severely contused spleen or kidney, suture wounds of the stomach and intestines, etc. We shall return elsewhere to the technique of these operations. Kocher saved a patient with a gunshot wound of the stomach by performing laparotomy and suturing the stomach (gastrorrhaphy) three hours after the injury. Mikulicz performed enterorrhaphy successfully in a case of

perforation of a typhoid ulcer of the small intestine followed by gangrenous peritonitis. Of nineteen such cases, four, according to Hock, were cured by laparotomy.

Whereas one formerly contented himself with an expectant treatment in cases of injury of the abdominal organs, prescribing opium and complete quiet, the tendency of late is toward prompt operative interference by resort to laparotomy, particularly in cases of gunshot wounds (Parkes, Kocher, Mikulicz, MacCormac, Senn, D. Barrow, A. C. Bernays, Lühe, Postempski, P. Klemm, H. Chaput, and others). Regarding the latter, the experiments of Parkes especially, and the observations of Senn, Dennis, and others are very instructive. Of thirty-seven dogs upon which Parkes inflicted gunshot wounds, fifteen died from injury of the large abdominal vessels or severe wounds of the internal organs, one from tetanus, and two likewise died which were but slightly injured, but were treated expectantly. Of the remaining nineteen, nine recovered after laparotomy, followed by suture or resection of the intestine and ligation of the injured vessels. D. Barrow, in addition to six observations of his own of gunshot wounds of the abdomen, analyzed in detail one hundred and twelve cases of laparotomy performed for such injuries. He also urges the performance of laparotomy in cases of gunshot wounds of the peritoneal cavity. With operation, the mortality is 66.27 per cent, whereas without operation it rises above ninety per cent.

Whether laparotomy should be performed in the linea alba or the peritoneal cavity opened by enlarging the existing wound, depends upon the nature of the case. If, for example, the injured intestine has prolapsed through the abdominal wound, and its contents have escaped externally only, it should be sutured after enlargement of the external wound, if necessary, outside the peritoneal cavity, and then disinfected and returned inside the abdomen.

If laparotomy is performed for injury of an abdominal viscus, the organ that is supposed to be injured is exposed by means of a sufficiently long incision, and the attempt made to determine the location of the injury, in the intestine or stomach, for example, or the cause of an existing peritonitis. If general peritonitis is already present, this is no counter-indication to laparotomy, but, on the contrary, it demands the quickest possible performance of the operation.

In case of perforations or wounds of the intestine, laparotomy will usually be performed in the linea alba between the umbilicus and the symphysis, if the injured portion of the intestine has not prolapsed through the wound and can not be sutured extra-abdominally. If laparotomy is performed as late as twenty-four hours after the injury

of the gastro-intestinal tract, and the contents of the bowel have entered the peritoneal cavity, the patient can usually no longer be saved. One should operate with all possible promptness, particularly in case of gunshot wounds. Of fifty-six patients with incised and stab wounds of the intestine who were operated upon, forty-two, according to MacCormac, recovered and fourteen died. In case of wounds and perforations of the stomach or upper part of the intestinal tract, the peritoneal cavity should be opened above the umbilicus; and if a wound of the stomach is certain, an oblique or transverse incision above the umbilicus is serviceable, as in resection of the pylorus (see § 165). Of eleven patients treated by laparotomy and suture of the wound in the stomach for stabs and incised wounds of the latter, ten, according to MacCormac, recovered and one died. In case of wounds and perforations of the cæcum or of the appendix, an oblique or curved incision parallel to Poupart's ligament and to the crest of the ilium is to be recommended. In case a longitudinal incision has been made in the linea alba, a transverse incision will often be added. After opening the peritoneal cavity so extensively, one must strive to maintain the normal temperature of the body, and particularly of the peritoneal cavity, by keeping the chest and extremities covered, by placing the patient upon warm water-bags or an operating table that can be heated, as well as by covering the intestines with moist, warm, aseptic compresses. The temperature of the operating room should be from 16° to 20° R. (68° to 77° F.). After opening the peritoneal cavity, any blood or exudation should be removed with sponges, the injured vessels ligated, and a search made for any wound of the stomach or intestines. A perforation is often extremely difficult to find, and this is true even at an autopsy. The best way is to examine first the stomach and then the intestine in its entire length from above downward. The discovery of a perforation is often made easier by the hæmorrhage, by a sacculated peritonitic exudation, or by a circumscribed peritonitis. Senn recommends, in doubtful cases of perforation of the stomach or intestine, rectal insufflation of air or hydrogen gas from an India-rubber balloon containing sixteen litres of air or gas, which is allowed to enter the rectum slowly and under steady pressure. The vomiting of blood, the passage of blood *per rectum*, and collection of air or intestinal gases in the cellular tissue of the wound are also indications of an injury of the gastro-intestinal tract. After the wound of the stomach or the intestine has been found, it is closed in the usual way by Lembert sutures of fine silk (see § 169, Technique of Gastrorrhaphy and Enterorrhaphy). Gangrenous or ulcerated edges should be excised, and in some cases a circular

resection of the injured part of the intestine is necessary (see Technique of Resection of the Intestine, § 169), the mesentery being properly detached beforehand, or a triangular piece excised from the same, and the defect closed by suture. In case of large openings in the intestinal wall, one may suture the wound, not longitudinally, but transversely, in order to avoid subsequent stricture.

After the stomach or intestine has been sutured, the peritoneal cavity should be carefully dried by means of aseptic sponges or aseptic gauze pads, and if peritonitis already exists the cavity should be irrigated with a warm, sterilized 0.75-per-cent solution of common salt or a three-per-cent solution of boric acid (see page 39), and then drained. After closure of the abdominal wound a large aseptic dressing is applied, especially in case drainage is employed. If the abdominal wound has been completely closed, it is sufficient to lay moss cushions or gauze and cotton upon the line of suture, and to secure these dressings with broad strips of adhesive plaster, or simply to paint the suture line with iodoform-collodion.

In case of wounds of the omentum the hæmorrhage should in the first place be carefully arrested, and any parts that have been too severely contused should be removed after tying them off with catgut.

In wounds of the liver, the hæmorrhage is arrested by continuous catgut suture of the peritoneal covering or by deep catgut suture, by use of the thermo-cautery, or by tying the larger vessels separately. In some cases the hæmorrhage can be arrested by compression with iodoform gauze, which is brought out through the partially sutured wound in the abdominal wall. Another way is to suture the injured portion of the organ—the liver, for example—into the abdominal wall outside the peritoneal cavity. In this way secondary hæmorrhages are easily treated.

Essentially the same course should be taken in treating wounds of the spleen and the kidney. In case of extensive injury of these organs or of the vessels before their entrance into the same, extirpation of the organ is indicated. In case of injury of the ureter also, it is often best to remove the involved kidney. In suitable cases the partial removal (resection) of the organs named is indicated. The partial or complete removal of a prolapsed spleen, whether injured or not, is, as regards prognosis, much more favourable than reposition of the organ (see § 164). For the treatment of injuries of the ureter see page 17. It is often necessary to remove the kidney on that side either at once or after making a ureteral fistula in the lumbar region. For the technique of extirpation of the spleen and kidney the reader is referred to the surgery of these organs (see §§ 164, 203).

In wounds of the bladder, also, laparotomy should be performed at once, and the wound exposed and sutured by going in above the symphysis, just as in suprapubic lithotomy. Drainage of the bladder through the perinæum, after performing external urethrotomy, is not so advisable, as the urine is then, in spite of antiseptic irrigations, more likely to decompose. The wound should be packed with iodoform gauze, which is brought out through the partially sutured abdominal wound. For the technique of suture of the bladder the reader is referred to § 207.

Death from hæmorrhage usually ensues very quickly after injury of the large vessels of the abdomen. It is only in the most exceptional cases that the injured person can be saved by ligation of the wounded vessel. The technique of ligation of the large abdominal vessels is given in the paragraphs that follow. If signs of internal hæmorrhage (severe bleeding from the wound, increasing anæmia, weak pulse, vertigo, unconsciousness, etc.) follow an abdominal injury, one should try at first compression of the aorta above the umbilicus—e. g., with the fist, with a couple of bricks wrapped in a cloth (Nussbaum), a tourniquet, a roller bandage, a long stick (broomstick, flagstaff, Esmarch), etc. If compression is not sufficient and the symptoms of anæmia increase in severity, ligation of the wounded vessel should be attempted quickly, even though the patient, who is lost at any rate, may die upon the operating table. Hæmorrhage from the vena cava is more easily arrested. The pressure even of an elastic loop of intestine or compression of the wound with iodoform gauze is here sometimes sufficient. Schede sutured with success a wound in the inferior vena cava. Suture of a large vein is accomplished as follows: The hæmorrhage is arrested by pressure with the finger above and below the wound in the vein or by catching the wound superficially with artery clamps, and a continuous catgut suture is then applied with small Hagedorn needles.

As is well known, venous hæmorrhage is easily arrested if the corresponding arteries are tied. Nussbaum accidentally wounded the vena cava in removing a tumour, and promptly tied the common iliac artery while an assistant made pressure on the wound in the vein. The hæmorrhage from the vein ceased after ligation of the artery, and he was enabled to tie the vein securely.

§ 157. **Ligation of the Large Arteries in the Abdomen (Aorta, Common, External and Internal Iliacs).**—*Ligation of the Abdominal Aorta.*—Nussbaum has found in the literature of the subject nine cases of ligation of the abdominal aorta. Ligation was performed in some cases for wounds and in others for aneurisms. Eight patients died in from four to sixty-three hours after the operation, and one lived eleven days

and twenty hours. He died in consequence of perforation of the aorta at the point of ligation.

Ligation of the aorta has been studied experimentally by Pirogoff, Porta, Maas, Kast, and Sonnenburg. Pirogoff operated upon eight dogs, four calves, three cats, and three sheep. With the exception of one dog and one cat, all these animals died in from twelve hours to nine days. The operation

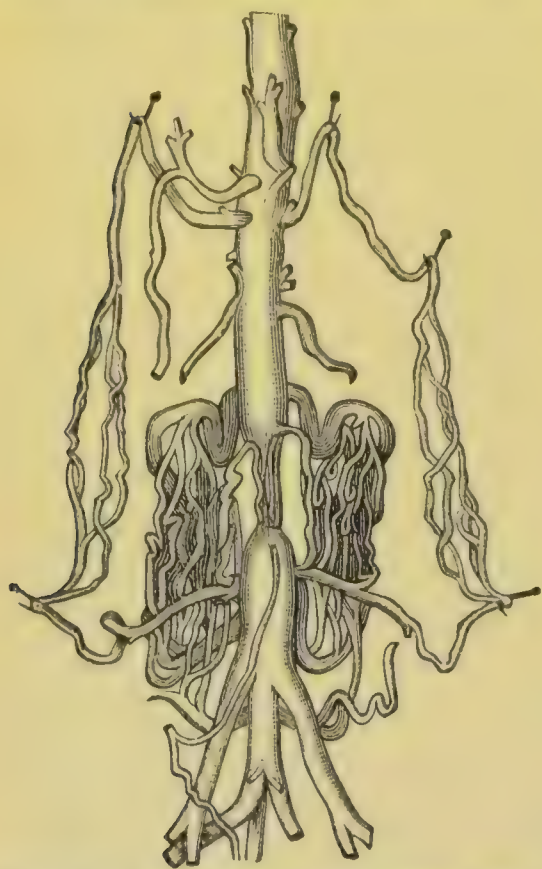


FIG. 421. — Collateral circulation eight months after ligation of the aorta in a dog (Luigi Porta).

causes death, according to Pirogoff, mainly in consequence of congestion of the lungs and heart and paralysis of the spinal cord. Porta performed sixty experiments upon animals, and only seven survived the operation. The collateral circulation takes place after ligation of the abdominal aorta through the internal mammary, the epigastric, the lumbar, and the circumflex iliac arteries. Porta obtained an interesting specimen from a dog eight months after ligation of the aorta, which shows that an abundant collateral circulation can be established through the vasa vasorum between the stumps of the aorta (Fig. 421). Paralysis of the hind extremities is only to be feared, according to Kast, in those animals which have thin abdominal walls, especially rabbits, while cats and dogs are only temporarily paralyzed, and survive the operation without permanent injury. In man, also, ligation of the aorta is not actually dangerous to life, according to Nuss-

baum and Kast, since neither local anæmia occurs in the peripheral parts nor dangerous hyperæmia in the centrally located parts of the body (heart, lungs, brain), and the fatal terminations that are observed are not to be looked upon as direct results of the operation itself.

Only the lower part of the abdominal aorta, in the vicinity of the third and fourth lumbar vertebræ, below the origin of the renal arteries, and as far down as the bifurcation, is suited for ligation.

The abdominal aorta lies behind the peritonæum, just in front of the spinal column, and to the right and anteriorly lies the inferior vena cava. Ligation is performed with or without opening the peritoneal cavity.

If intraperitoneal ligation is to be performed, one may choose either the method of A. Cooper (Fig. 422, 1) or that of Nussbaum. The peritonæum has to be divided twice. Among the extraperitoneal

methods, that of Murray (Fig. 422, 2) and of Maas are especially to be recommended.

I. Intraperitoneal Ligation of the Abdominal Aorta.—*Cooper's Method* (Fig. 422, 1): An incision is made about ten centimetres long, which lies half above and half below the umbilicus and encircles the latter upon the left side. After the peritoneal cavity has been opened in the linea alba, the intestines are displaced to the right and the posterior layer of the peritonæum is divided bluntly in front of the spinal column with a grooved director, and the aorta is carefully isolated and tied, the ligature being tightened very gradually.

James recommended the same incision, with the difference only that it should extend eight centimetres below and only two centimetres above the umbilicus.

Nussbaum's Method: An incision from fifteen to twenty centimetres long is made in the linea alba, encircling the umbilicus on the left as in Cooper's method. Here, also, the intestines are displaced to the right and held to one side by an aseptic compress. Otherwise the method is the same as Cooper's. The abdominal wound is sutured in the usual way. In consequence of the long abdominal incision, Nussbaum's method greatly facilitates the access to the aorta, and it makes a free view into the peritoneal cavity possible. It is therefore most to be recommended. The operation itself, under strict asepsis, is not more dangerous than ovariectomy with moderate adhesions.

II. Extraperitoneal Ligation of the Aorta.—*Murray's Method* (see Fig. 422, 2): A semilunar incision about eight or ten centimetres long is made in the left lumbar region, in the continuation of the axillary line, at a distance of about twelve centimetres from the umbilicus. The convexity of the incision is directed toward the umbilicus. After dividing the abdominal wall down to the peritonæum, the latter is bluntly detached with the fingers from the left lateral and posterior wall of the abdomen until one reaches the spinal column, and can here isolate the aorta.

Maas's Method: A lumbar incision is made, as in Murray's method, from the last rib, as far as the crest of the ilium, along the anterior

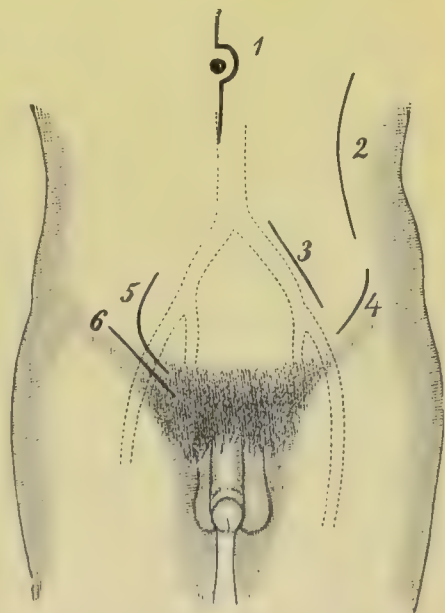


FIG. 422.—Ligation of the large arteries of the abdomen: 1 and 2, incisions for ligation of the aorta; 3, 4, 5, incisions for ligation of the common and internal iliacs; 6, ligation of the external iliac.

border of the quadratus lumborum muscle. If the transversalis fascia is cut through and the peritonæum pushed back, one then gets a view of the retroperitoneal space from the lower end of the kidney on. The left ureter and the spermatic artery, which lie alongside the aorta, can be easily distinguished.

Of the methods that have been mentioned, those of Nussbaum and Maas are, perhaps, most strongly to be recommended.

Embolism or thrombosis of the abdominal aorta, especially at its bifurcation, which is of rare occurrence, should be mentioned here. P. Selter, after an observation made in Strasburg, collected nineteen analogous cases from literature. The embolus lodges by preference, as can readily be understood, at the point of bifurcation of the aorta. Embolism of the aorta does not, according to Selter, very frequently occasion death directly (only four times in twenty cases), but it gives rise to serious circulatory disturbances, gangrene, etc., which cause death secondarily.

Ligation of the Common Iliac Artery.—The aorta divides at the lower border of the fourth lumbar vertebra into the two common iliac arteries, which run obliquely downward and outward along the inner border of the psoas muscle toward the sacro-iliac synchondrosis, and here divide on each side into the external and internal iliac arteries (Fig. 422). The vein of the same name is on the right side external and on the left side internal to the artery. The length of the common iliac artery, which gives off no branches, is about six centimetres. Various methods for ligating this artery have been recommended which are chiefly extraperitoneal. The intraperitoneal method is, however, simpler and quicker (see below). In order to gain sufficient room, the incisions must be from about twelve to fifteen centimetres long. Uhde collected seventeen cases of ligation of the common iliac artery from the period preceding the adoption of antiseptic methods in surgery. Six of these had a favourable termination.

1. *Dittrich's Method* (Fig. 422, 3): This method affords the most space. The incision, which is about twelve centimetres long, begins at the outer border of the rectus about six centimetres above an imaginary line drawn transversely from the anterior superior spine to the linea alba, and runs obliquely downward and outward toward the middle of Poupart's ligament. After dividing the skin, the muscular layers of the abdominal wall, and the transversalis fascia, the properitoneal adipose tissue is reached and the peritonæum is detached bluntly with the fingers, and retracted upward toward the umbilicus. The ureter and the spermatic artery are also displaced upward with the peritonæum. The artery is found running in the direction of the cutaneous incision. The aneurism needle is passed around the artery from

without inward on the right side, and from within outward on the left side.

2. *Mott's Method* (Fig. 422, 4): The incision, which is from twelve to fifteen centimetres long, begins about two fingers' breadth above and to the inner side of the anterior superior spine of the ilium and passes downward in a slight curve toward Poupart's ligament. It ends about one centimetre and a half above this ligament, one finger's breadth to the outer side of its centre, and laterally from the internal inguinal ring. After dividing the skin, the superficial fascia, and the external oblique muscle, the internal oblique is divided far enough to expose the spermatic cord. The forefinger is then introduced into the internal inguinal ring, along the spermatic cord, and protects the peritonæum from injury, and the internal oblique and transversalis muscles are divided, together with the transversalis fascia. After blunt detachment of the peritonæum to a point near the promontory, one can isolate and then tie the artery in the manner described above.

Duval modified the cutaneous incision in the way shown in Fig. 422, 5.

Ligation of the common iliac is most easily performed intraperitoneally by opening the abdominal cavity in the linea alba or at the outer border of the rectus muscle, or by means of the incisions described above.

The collateral circulation takes place through the anastomoses between the internal iliac artery of the sound side and the middle sacral and lateral sacral arteries of the ligated side, also through the anastomoses between the inferior epigastric and the internal mammary arteries, and between the lumbar arteries and the circumflex iliac artery.

Ligation of the Internal Iliac Artery.—The trunk of the internal iliac artery, which is about four centimetres long, descends on both sides with a slight curve in front of the sacro-iliac synchondrosis, and, passing backward and outward, enters the true pelvis. The same incisions hold good for ligation of the internal iliac artery that we have just described for ligation of the common iliac. The place of division of the common iliac artery is first exposed, and from here the internal iliac is sought out. The vein of the same name is external to it on the right side and more posterior on the left. Of the branches of the internal iliac, ligation of the superior and inferior gluteal arteries is of special importance (see § 261, Surgery of the Pelvis).

Ligation of the External Iliac Artery.—The external iliac artery runs from the sacro-iliac synchondrosis along the inner border of the psoas muscle obliquely outward and downward toward Poupart's ligament to the middle of a line connecting the anterior superior spine of the

ilium and the symphysis. The vein lies to the inner side of the artery, and hence the short trunk of the circumflex iliac vein crosses the artery about one centimetre above Poupart's ligament. The circumflex iliac vein must not be wounded in isolating the artery, as profuse recurrent hæmorrhage from the iliac vein would ensue. The best way is to isolate and tie the external iliac artery above the circumflex iliac vein—that is, more than one centimetre above Poupart's ligament. The trunk of the external iliac artery is about eight centimetres long. The ureter crosses the point of division of the common iliac artery, and the internal spermatic artery crosses the external iliac near Poupart's ligament. The vas deferens runs along the inner side of the vessel from the internal inguinal ring into the true pelvis. The external iliac artery gives off its first branches below Poupart's ligament—viz., the inferior epigastric and the circumflex iliac.

Ligation of the external iliac artery is best accomplished by means of an incision which begins a thumb's breadth from the anterior superior spine of the ilium and one and a half finger's breadth above Poupart's ligament, runs parallel to this (Fig. 422, 6), and ends a thumb's breadth from the spine of the pubis. The centre of the incision should correspond approximately to the middle of Poupart's ligament. After dividing the skin, the superficial fascia, the external oblique, the internal oblique, and the transversalis muscles and the transversalis fascia, the peritonæum is detached bluntly with the fingers and pushed upward. The artery can then be easily isolated. The aneurism needle and thread are passed around the artery from the side on which the vein lies—i. e., from within outward.

§ 158. **Peritonitis.**—Acute peritonitis results most frequently from microbic infection following the greatest variety of injuries, especially penetrating abdominal wounds with or without injury of the abdominal organs; from operations within the peritoneal cavity not performed aseptically; from traumatic and inflammatory perforations of the stomach, the intestines, or the appendix with escape of the contents of the gastro-intestinal tract into the peritoneal cavity; from an abscess of the liver, the kidney, and the spleen; from rupture or extension of an extraperitoneal inflammation—e. g., of the pleura, the spinal column, the pelvis, the abdominal wall, etc. In still other cases acute peritonitis has arisen metastatically in consequence of pyæmia, septicæmia, or acute infectious diseases—the acute exanthemata, for instance. Bumm divides septic (not the suppurative) peritonitis into two principal forms: putrid peritonitis and streptococcus peritonitis. E. Fränkel questioned the correctness of this classification, as he always found streptococci in connection with the forms of peritonitis designated by Bumm as

putrid (see also Principles of Surgery, § 59, p. 252, Morphology and General Significance of Micro-organisms). In exceptional cases the origin or the means of entrance of the infection is unknown. Suppurative peritonitis is caused most frequently by the streptococcus and diplococcus and less frequently by the staphylococcus pyogenes. In peritonitis following perforation of the intestine the *Bacillus coli communis* is also present (P. Ziegler, Barbacci). The latter, however, is, according to Tavel and Lanz, not the chief exciter of peritonitis, which, on the contrary, may be caused by a great many micro-organisms, and is in most cases a polyinfection. The *Bacillus coli communis* is not a bacteriological unit, Tavel and Lanz having cultivated thirty-one different varieties. They hold the view that a chemical peritonitis, so to speak, always precedes the bacterial—i. e., the micro-organisms that have gained entrance to the abdominal cavity do not begin to develop and form poisonous products of metabolism until the peritonæum has been injured in some way chemically or anatomically, and is in a favourable condition for the development of bacteria. But besides this peritonitis due to bacterial infection there is a purely toxic fibrino-suppurative peritonitis without micro-organisms in the exudate (Schroeder, Hartmann, Morax), which occurs, for example, from rupture, torsion, and inflammation of ovarian cysts. The prognosis in such cases is good if the cause can be removed.

The large surface of the peritonæum, with its various recesses and numerous lymph vessels, which are in open communication with the peritoneal cavity, is very susceptible to microbic infection. All operations in the peritoneal cavity should therefore be performed with the most scrupulous cleanliness and under the strictest observance of aseptic methods. We know, on the other hand, that the peritonæum can withstand the severest operative interference if aseptic methods are used, and if the peritoneal cavity is kept from being chilled. Rapidly fatal collapse may follow chilling of the cavity without inflammation proper.

Acute peritonitis is either a serous, sero-fibrinous, suppurative, or putrid inflammation. It is sometimes circumscribed and sometimes diffuse.

Chronic peritonitis develops especially in connection with the healing of an acute peritonitis, or arises very gradually as such, in consequence of the greatest variety of diseases of the abdominal cavity, passive congestion from circulatory disturbances, etc. The same forms occur here as in acute peritonitis—that is, serous, sero-fibrinous, or suppurative inflammations which are either circumscribed or more diffuse.

Every case of chronic peritonitis has the tendency to pass very easily into an acute inflammation, whether it be that some new infection ensues from without or that micro-organisms are still present in an encapsulated, circumscribed focus and occasion inflammatory relapses from time to time—e. g., after traumatic irritations. This explains the frequent recurrences which attend chronic peritonitis, encapsulated fæcal abscesses which communicate with the intestine, perimetritis, parametritis, oöphoritis, etc. If it is necessary to perform laparotomy in connection with diffuse, chronic, sero-fibrinous peritonitis, acute, septic peritonitis is very likely to develop, because the inflamed peritonæum is extremely susceptible to infection.

Anatomical Changes attending the Various Forms of Acute Peritonitis.—The most favourable forms of acute peritonitis are the serous and sero-fibrinous inflammations with the formation of serous and sero-fibrinous exudates in varying amount without pus.

The severest type of acute peritonitis is the diffuse suppurative or putrid form, which is caused mainly by the streptococcus pyogenes, the diplococcus, and more rarely the staphylococcus (see page 34). All sorts of vague causes were formerly thought to be at fault. This form of acute peritonitis usually spreads very rapidly over the entire peritonæum. It is characterized at first by congestion and then by the formation of coatings of fibrin and pus. The coils of intestine are distended, adherent in different places, and easily torn. The peritoneal cavity is often very much distended in consequence of the tympanites. The quantity of pus, especially in the small pelvis, is sometimes very large. The exudate is often sanious, discoloured, and mixed with gases. Many cases of septic peritonitis run such a rapidly fatal course in consequence of the systemic intoxication due to the toxins that are formed by the microbes, that one finds at the autopsy only slight adhesions of the intestinal coils and a little turbid serum. Contents of the stomach and intestines are found in the peritoneal cavity in varying amount after perforations of the gastro-intestinal tract, and in these cases there is usually a large amount of gas which collects in the upper part of the peritoneal cavity under the diaphragm.

Localized suppurative inflammation of the peritonæum is much more favourable than general peritonitis, if the pus focus is encapsulated by adhesive peritonitis—e. g., by adhesions of neighbouring coils of intestine with one another or with the parietal peritonæum. The rest of the peritonæum is protected from inflammation in this way, and if the circumscribed abscess ruptures into the intestine, the stomach, the bladder, etc., recovery may ensue from absorption or calcification, or finally after laparotomy. In such cases adhesions of the abdominal organs remain behind—e. g., adhesion of the omentum, or the stomach with the abdominal wall, of the intestinal coils with one another, and with the parietal peritonæum; or fibrous bands are formed which may cause constriction of the intestine, internal strangulation, or severe colicky pains. Very prolonged suppuration with fistulæ often results from such encapsulated peritonitic abscesses, which may communicate in the greatest variety of ways with the abdominal organs—e. g., with the stomach, the

intestine, the gall bladder, the urinary bladder, etc. Every case of local, suppurative peritonitis may lead at any time to acute general suppurative peritonitis with a speedy fatal termination.

We have already spoken of the anatomical changes which attend chronic peritonitis. Chronic serous or sero-fibrinous effusions are observed especially in carcinoma or tuberculosis of the peritonæum, in connection with chronic congestion from cirrhosis of the liver for instance, and in the greatest variety of diseases and tumours of the abdominal cavity. Chronic suppurative peritonitis is chiefly circumscribed and encapsulated, as we have described it above. Chronic peritonitis sometimes develops from the acute form and sometimes begins very gradually as such. The above-mentioned adhesions, indurations, and thickenings occur especially in connection with chronic peritonitis on the locally inflamed part of the peritonæum, or they may be more or less diffusely spread over the entire peritonæum (peritonitis deformans), and are usually combined with sacculated or diffuse serous or sero-fibrinous exudates or encapsulated collections of pus.

As regards the symptomatology of peritonitis, the surgeon is interested mainly in the clinical course of acute peritonitis following injuries of the peritoneal cavity and after laparotomy.

The first and most constant symptom of acute general peritonitis is vomiting. The vomited material is usually of a characteristic spinach-green colour. After an abdominal operation has been performed, vomiting likewise occurs in consequence of the anæsthetic and nervous excitement, and it is not infrequently very profuse. The vomiting in peritonitis can be recognised by the fact that the abdominal muscles are used much less than in vomiting after taking chloroform or ether, and in peritonitis comparatively large quantities of a greenish or blackish material are vomited. There is sometimes also fæcal vomiting, as in intestinal obstruction.

Fever is always present in acute peritonitis. The temperature often rises rapidly, preceded by a chill, to 40° , 40.5° , and even 41° C. (104° , 105° , 106° F.). The fever may continue up to the time of death, or there may be at the end a very low collapse temperature. The pulse is weak and rapid (110, 130, 150, and more). Among local symptoms, increasing tympanites and pain are chiefly prominent. The pain, which is usually severe, especially on pressure, is frequently circumscribed at first—that is, is felt at the place where, for example, the injury occurred, but soon the entire peritonæum becomes very tender. The patient also complains of a feeling of fulness, the abdomen becomes more and more distended, and the peristalsis of the intestines is diminished or completely suspended, so that the intestinal gases do not escape *per rectum*. The diaphragm is pressed upward in consequence of the tympanites of the intestines, so that there is interference with the action of the lungs and the heart, and respiration is superficial and much accel-

erated (thirty to forty or even fifty in a minute). The distention of the abdomen is sometimes extremely great, especially when there is an abundant exudation of pus. Percussion of the abdomen shows tympanitic resonance over the distended intestinal coils and the stomach, and dullness in the region of sacculated collections of exudate. This dullness is found, generally speaking, in the lower parts of the abdomen, where the exudate usually lies. In case of extreme tympanites there is generally high tympanitic resonance over the whole abdomen. The urine is scanty in amount, dark-coloured, and usually contains considerable sediment.

It is of great practical importance that patients with septic peritonitis often feel perfectly well and then die suddenly with symptoms of collapse. At the autopsy of such cases only very slight changes are found in the peritoneal cavity. Death is conditioned mainly upon absorption of the toxins produced by the micro-organisms.

General septic peritonitis usually ends fatally from the fourth to the sixth day, sometimes in twenty-four hours. If recovery follows, the course is generally very chronic, covering weeks, months, or even years. The first favourable signs are usually an increased secretion of urine and an abatement of the peritonitic symptoms, especially the pain and the tympanites. As the patient begins to feel better, the skin becomes moist. The exudate becomes encapsulated, absorbed, calcifies, or ruptures into the intestine, the stomach, the bladder, the thorax, etc., or is removed by an operation. Recovery is possible at the outset if the focus of inflammation, after perforation of the stomach or intestine, for example, has been completely shut off from the rest of the peritoneal cavity by adhesive peritonitis. Such patients, however, with chronic local peritonitis, are in constant danger of sudden death from general peritonitis, from erosion of a large vessel, or from pyæmia or sepsis.

The prognosis of acute traumatic peritonitis is almost always fatal if the inflammation has involved the entire peritonæum. We have already mentioned the possibility of recovery from circumscribed processes.

The course of chronic peritonitis is indicated by what we have already said in connection with the anatomical changes and the course and termination of acute peritonitis. The prognosis of chronic peritonitis also is always doubtful so long as a circumscribed exudation is present.

Treatment of Acute Traumatic Peritonitis.—Prophylaxis is of the greatest importance—that is, all operations within the peritoneal cavity should be performed with the strictest observance of antiseptic precautions. In case of already existing peritonitis it was formerly the rule

to adopt an expectant treatment. Opium was administered in order to diminish the peristalsis and to favor the encapsulation of the inflammatory products. Other suitable measures were also taken (attention to diet, the use of ice, or, better, warm, moist compresses upon the abdomen, etc.). In every case of acute peritonitis opium should be given in large doses. At present the peritoneal cavity is opened by performing laparotomy, and the further measures depend upon the condition of things that is found to exist. The exudate is removed by means of aseptic sponges or gauze pads and the peritoneal cavity drained—e. g., through the abdominal wound in the linea alba if the patient is to lie on his stomach, or in the lumbar region if he is to lie on his side, or, in case of a female patient, through Douglas's pouch, the vagina, etc. Irrigation of the peritoneal cavity with a one-third-of-one-per-cent solution of salicylic acid, a from two- to three-per-cent solution of boric acid, or a sterilized solution of common salt, etc., should, in my opinion, be dispensed with as far as possible. These irrigations should be undertaken only in fresh cases of perforative peritonitis. The rule of most importance is, as it seems to me, to perform the operation as rapidly and simply as possible—that is, to remove the pus from the peritoneal cavity and to provide for the free escape of the secretion by drainage. Further manipulations in the inflamed cavity only favour collapse in a dangerous manner. Too great cooling off of the patient or of the peritoneal cavity is also to be avoided by having the operating room warm, by placing the patient upon a warmed operating table (Socin, Kocher), as well as by covering the intestines with warm aseptic gauze compresses. Without these precautions death from collapse easily ensues after the operation. Sufficient drainage of the peritoneal cavity is always the greatest difficulty. This is scarcely possible, because the peritoneal surfaces adhere quickly and retention of secretion arises therefrom. The best drainage is secured, no doubt, by the use of bags of iodoform gauze, after Mikulicz, or of strips of iodoform gauze combined with drainage-tubes of India rubber or glass.

The operative treatment of circumscribed serous or suppurative exudates by evacuation of the same by puncture or incision with drainage is, of course, much more hopeful.

Aside from prompt operative treatment of diffuse peritonitis, the general adoption of which is, in my opinion, merely a question of time, treatment will be of a symptomatic character. Opium is administered, as has been said, in large doses. Nussbaum recommends giving one to two centigrammes of opium every half hour until the pain is relieved, and then giving the same dose every four or five hours. Half

a centigramme may be given to children every half hour likewise, and less after the pain is relieved. To prevent vomiting, morphine should be given hypodermically—e. g., two centigrammes every four or five hours—or opium in the form of an enema (two tablespoonfuls of warm water with fifteen drops of tincture of opium, or in suppositories every three or four hours), until the vomiting and pain diminish. To prevent singultus, Nussbaum recommends applying thirty grains of collodion to the epigastrium, also hypodermic injections of morphine, strong chamomile tea, and, if necessary, inhalation of chloroform.

Warm, moist compresses upon the abdomen are very serviceable, as well as warm baths, and broken ice to quench the thirst. The food should be fluid and little in amount. Bouillon is very good. In case of collapse, ether is administered hypodermically, and camphor, wine, champagne, etc., are given. In case of extreme tympanites arising from accumulation of gas in the peritoneal cavity or in the intestines, the question arises of puncture of the peritoneal cavity with a fine trocar or aseptic incision. The intestine may also be punctured with a fine aspirating needle. These punctures of the intestine have only a palliative value. The danger of escape of faeces into the peritoneal cavity through the small puncture wound in the intestine seems not to be great. In case of abundant exudation, laparotomy is always better, no doubt, than puncture of the peritoneal cavity, and the gas can then be removed from the distended intestine by an incision.

For the technique of puncture and incision of the peritoneal cavity (laparotomy), the reader is referred to § 159, p. 45.

The treatment of chronic peritonitis is directed chiefly against any exudation that may be present. In case of serous and sero-fibrinous exudates aspiration is employed. Encapsulated abscesses should be evacuated by an incision and drained. In cases of chronic sero-fibrinous exudations Nussbaum recommends inunction of mercury and methodical massage as soon as the inflammatory symptoms have disappeared. Warm baths, particularly mud baths, by which the absorption of the inflammatory exudate is favoured, are very serviceable in chronic peritonitis. The treatment of chronic peritonitis varies greatly according to its origin. It is therefore very important to determine as accurately as possible in each case the cause of the chronic inflammation, and, if necessary, to remove this cause by laparotomy.

Inflammatory adhesions of the peritonæum sometimes give rise later to severe disturbances, such as pain, intestinal colic in case of adhesions of the intestine, gastric disturbances, biliary symptoms, etc. In such cases laparotomy with separation of the adhesions may be indicated.

Tubercular Peritonitis is not infrequently the subject of surgical treatment. It is also of special interest for the surgeon with reference to the differential diagnosis of the diseases of the peritoneal cavity. The following brief description may therefore be given here :

Tubercular peritonitis usually arises secondarily from tuberculosis of the pleura or the abdominal organs, especially of the intestine, the ovary, the bladder, the testicles, the mesenteric glands, the spinal column, etc., so that in such cases the continuous extension of the primary local focus is clearly demonstrable. In other cases this continuous connection of tubercular peritonitis with a local tuberculosis of the peritoneal cavity or its vicinity can not be made out, but the peritonæum has been infected from some distant tubercular focus through the circulation or the lymphatics. In case of the conveyance of tubercle bacilli through the lymph passages, the retroperitoneal lymph glands are found to be diseased. Direct infection of the peritonæum occurs in not a few cases. The source of tubercular peritonitis is sometimes thoroughly obscure, and the original tubercular focus from which the infection proceeded is first discovered at the autopsy.

Tubercular peritonitis is characterized anatomically by the formation of miliary tubercles in the vicinity of the original focus—e. g., near tubercular ulcers of the intestine or along the course of the vessels and the lymph glands or the lymphatics in case of infection through the blood or lymph. Numerous miliary tubercles are often found in the omentum. In case of direct infection of the peritonæum with tubercle bacilli, a very rapid and abundant formation of miliary tubercles is sometimes observed, because in such cases the tubercle bacilli are spread by means of the peristalsis over the entire peritoneal cavity. A local or more general congestion is found depending upon whether the tuberculosis is circumscribed or more diffuse. The miliary tubercles often coalesce and form large nodules or caseous areas. The amount of the serous and sero-fibrinous encapsulated or free exudate is very variable. The effusion is sometimes marked, as, for example, in two cases of general miliary tuberculosis of the peritonæum with numerous nodules, some of them as large as a hazelnut, which I recently treated by exploratory laparotomy. In both cases I supposed at the operation that I had to deal with carcinoma of the peritonæum following a primary carcinoma of the stomach or the liver, but the further examination of the patient, who died some weeks later, revealed tuberculosis. Such cases are of great interest from a practical and especially from a diagnostic point of view.

Aside from serous and sero-fibrinous exudations, hemorrhagic and purulent tubercular effusions are also observed. In the later stages of tubercular peritonitis the peritonæum and omentum become thickened and contracted.

The prognosis of tubercular peritonitis is very unfavourable. General tuberculosis of the peritonæum and death from increasing marasmus, as in carcinoma, follow comparatively soon. Tuberculosis of the intestines and of the lungs is also usually present, and in case of the former, death not infrequently comes suddenly from perforation of the intestine. Isolated, circumscribed tubercular peritonitis may be cured, especially if it is accessible for operation ; but even general tubercular peritonitis has been completely cured by laparotomy. I believe that tuberculosis of the peritonæum is often

caused by attenuated tubercle bacilli, and hence this form runs a more favourable course and can be cured by operation.

The diagnosis of tubercular peritonitis is often impossible without exploratory laparotomy. It is very probable, however, when in persons otherwise affected with tubercular disease there appear tenderness of the abdomen, ascites, and gastro-intestinal symptoms.

As regards the treatment of tubercular peritonitis, the effort should be made to cure circumscribed local tuberculosis by laparotomy. The tubercular focus is scraped out and drained, the tubercular portion of the intestine is in suitable cases resected, tubercular mesenteric glands excised, etc. Surprising improvement and permanent cures even have been brought about recently in general tuberculosis of the peritonæum also by means of laparotomy, with removal of the tubercular exudate and separation of the tubercular adhesions, and even by simply opening the peritoneal cavity without other operative interference (Ceccherelli, H. Hartmann, A. Aldibert, and others). In the cases of Keetley and Schmitz, in which some time after the first laparotomy for tuberculosis the abdomen was reopened for other reasons, a complete cure of the tuberculosis was found to have taken place. The improvement has been, however, only temporary in most cases, inasmuch as tubercular peritonitis, as was stated above, and as Czerny also rightly maintains, is usually secondary, and the primary focus is found in the pleura, in the mucous membrane of the intestine, in the genito-urinary organs, in the mesenteric glands, etc. A. Aldibert estimates 35·4 per cent of permanent cures for the ascitic form of tuberculosis at least one year after the operation; fifty per cent of permanent cures out of eighty per cent cures for the dry, fibrous, or the fibro-adhesive form; and of 59·1 per cent of apparent cures for the ulcerative and suppurative forms, scarcely a fourth part prove permanent. Rörsch, who collected three hundred and fifty-eight cases of tubercular peritonitis treated by operation, reached similar conclusions.

A satisfactory explanation of these improvements or cures of tubercular peritonitis in consequence of simply opening the peritoneal cavity, with evacuation it may be of the tubercular ascites, is not possible as yet. Perhaps the removal of the abnormal pressure caused by the fluid, the improved circulation, the fact that the lymph passages are again patent, and the independent absorbent and "digestive" powers of the peritonæum, play a part in connection with this improvement and healing (H. Lindner). The larger number of patients upon whom laparotomy is performed are females in whom the infection often gains access to the peritonæum through the generative organs. Tubercular peritonitis should be subjected to surgical treatment more frequently than heretofore and with all possible promptness, as O. Vierordt also expressly recommends. In my opinion, miliary tuberculosis with ascites is especially adapted for laparotomy, and also the dry, fibrous, fibro-adhesive form. The dry, adhesive form with tumourlike nodules and the ulcerative and suppurative forms are less suited for this treatment, as Helmrich also properly states, and as is shown by the above-mentioned statistics of Aldibert.

Tumours of the Peritonæum.—Primary tumours of the peritonæum are rare. E. Wagner, Birch-Hirschfeld, Schultz, Neelsen, and others have

described a primary endothelioma of the peritonæum which has the form of multiple bands and white, frequently medullary nodules. A serous and sero-fibrinous exudation was usually present. These endotheliomata arise from proliferation of the endothelial cells of the lymph vessels and those of the peritonæum itself. Primary connective-tissue tumours, such as sarcomata, fibromata, and lipomata, are very rare. They originate partly in the serous layer and partly in the subserous tissue. Sarcomata with a very rapid course are sometimes observed in the omentum. Lipomata may also arise from hypertrophy of the epiploic appendices on the large intestine, and after detachment of their pedicle they may become free fatty bodies in the peritoneal cavity. Primary angeiomata and lymphangeiomata of the peritonæum are rare. Weichselbaum described a chylous angeioma of the mesentery. We shall speak more in detail of cysts, dermoids, and teratomata—that is, cysts containing a rudimentary fœtus—in connection with diseases of the ovary. The echinococcus sometimes occasions the formation of large cystic growths, especially in the omentum (Trendelenburg, Witzel). Among cysts, those of the mesentery in particular are of practical importance. Serous cysts, sanguineous cysts, chylous cysts, and echinococcus cysts have always been found in the mesentery of the small intestine. Cysts of the transverse mesocolon and of the flexura coli have never been described (A. Frentzel). The diagnosis of mesenteric cysts may be difficult. Serous cysts are located mostly in the median or lateral part of the abdomen, are often adherent to a coil of intestine, and show no connection with the other organs (liver, kidney, ovary) from which cystic tumours develop.

The greatest variety of secondary tumours is observed in the peritoneal cavity, most frequently small or large sarcomatous and carcinomatous nodules following sarcoma and carcinoma of the abdominal organs—e. g., the stomach, the intestines, or the liver. They are often found in the omentum, where they cause corresponding induration and contraction of the same.

All tumours that originate in the peritonæum, especially in the omentum and the mesentery, sometimes present great diagnostic difficulties. Their nature and location are particularly hard to determine if there is much ascites. The latter should therefore be removed beforehand by aspiration. Usually, however, an exploratory laparotomy or the autopsy of the patient first affords the correct diagnosis.

The treatment of tumours of the peritonæum conforms to general principles. Single tumours are removed by aseptic laparotomy, of which we shall speak more in detail in connection with the treatment of tumours of the different abdominal organs. Laparotomy is always

to be recommended for mesenteric cysts. Their complete enucleation is usually impossible, so that the best plan is to open the cyst, suture its edges to the abdominal wound, and drain it (Terrillon). Exploratory puncture of cysts of the abdomen through the uninjured abdominal wall is always to be avoided as too dangerous (peritonitis, injury of the intestines, etc.). In case of solid tumours—sarcomata of the mesentery, for example—one may be compelled to resect the intestine. In diffuse carcinoma and sarcoma of the peritonæum all surgical treatment is useless.

Retroperitoneal tumours vary greatly according to their nature and origin. Very large fibro-sarcomata, lipomata, dermoids, and interesting mixed tumours have been observed here most frequently. We shall return to these when treating of tumours of the kidney and the pancreas. Retroperitoneal cysts originate most frequently, as we shall see, in the pancreas. Secondary tumours frequently develop in the retroperitoneal lymph glands—for example, from sarcoma of the testicle and malignant tumours of the female generative organs. The location of the primary tumour is often first made out at the operation. Large retroperitoneal tumours, in case they can not be removed extraperitoneally, should be extirpated by laparotomy, which involves dividing the peritonæum twice. Madelung removed successfully a large retroperitoneal lipoma. Large dermoid cysts or pancreatic cysts should be sutured into the abdominal wound, and then, after union of the sac, incised and drained (see *Pancreatic Cysts*).

§ 159. **Operations for opening the Peritoneal Cavity.**—The peritoneal cavity may be opened either by puncture or incision—i. e., laparotomy.

Puncture or paracentesis of the abdomen is performed either for exploratory purposes or for the removal of fluid from the peritoneal cavity. Every puncture must be performed with strict observance of antiseptic precautions, and the entrance of air into the peritoneal cavity is always to be avoided. The area of skin where the puncture is to be made must first be cleansed with lukewarm water and soft soap, shaved, rubbed with ether, and scrubbed with 1-to-1,000 bichloride. The aspirating needle or trocar must be sterilized by boiling it in a one-per-cent solution of soda, and placing it in a from three- to five-per-cent solution of carbolic acid. The place at which the needle or trocar should be inserted depends mainly upon the location of the fluid. It is usually introduced in the lower lateral region of the abdomen, in an imaginary line drawn from the anterior superior spine of the ilium perpendicular to the free border of the ribs. Injury of the inferior epigastric artery, which passes upward from the middle of Poupart's ligament to the lateral border of the sternum, is thus most surely

avoided. Some surgeons recommend inserting the needle exactly in the linea alba on account of the varying course of the epigastric artery.

Exploratory puncture of the peritoneal cavity for diagnostic purposes is made with an aseptic aspirating syringe. After inserting the needle the fluid is drawn up into the barrel of the syringe by traction on the piston.

We shall occupy ourselves here chiefly with puncture or tapping of the peritoneal cavity for ascites. The location of the intestine and of the fluid is first determined by percussion. The former is usually found in the upper part of the peritoneal cavity, while the free exudations usually lie in the lower part. The patient is generally placed on the side, near the edge of the bed, whereby the fluid sinks toward this side, and the lighter intestine rises to the elevated side. The trocar is then grasped by the whole hand in such a way that the forefinger rests on the canula of the instrument. The trocar is thrust into the peritoneal cavity, the stylet is withdrawn from its sheath, and the fluid escapes. If the canula becomes obstructed, it is cleared again by introducing a probe. The fluid should not be drawn off too rapidly from the peritoneal cavity for fear that too sudden diminution of pressure should lead to a severe hyperæmia of the abdominal viscera at the expense of the central organs. For the same reason all of the fluid is not removed, but only sufficient to relieve the discomfort of the patient. No effort should be made, therefore, to aid the escape of the fluid other than by a moderate compression of the abdomen with the hands or a bandage. After sufficient fluid has been removed the canula is closed with the tip of the forefinger, and then withdrawn. The opening in the abdominal wall is closed at once with the finger and then with iodoform-collodion, or, in case it is larger, with an antiseptic protective dressing.

In order to prevent the entrance of air into the peritoneal cavity, special trocars have been constructed, much the same as for aspiration of the pleural cavity (see vol. ii, p. 703, § 126). These can, however, usually be dispensed with.

We have already mentioned (page 40) puncture of the intestine with very fine hollow needles for extreme tympanites.

For the technique of puncture of cystic tumours—e. g., of the ovary or hydatid cysts of the liver—the reader is referred to the surgery of those organs.

Laparotomy.—Before every laparotomy the patient should receive proper preparation. He should take a full bath, the intestines and bladder should be emptied, the abdomen shaved, disinfected, etc. All the instruments that are to be used in the operation should be steril-

ized by boiling them for five minutes in a one-per-cent solution of soda, and the operating room must have a temperature of from 16° to 20° R. (68° to 77° F.). If the operation is a long one, too great cooling off of the patient or the peritoneal cavity must be prevented by covering him with warm blankets, by placing him on warm water-bags, by protecting the intestines with moist and warm aseptic compresses, etc. Too great lowering of the temperature may quickly cause a fatal collapse from paralysis of the heart and lungs, as Wegner was the first to show experimentally. After the temperature of the peritoneal cavity had been lowered to 32° C. (89.6° F.) the animals experimented upon (dogs, rabbits) became more and more somnolent, and died from paralysis of the heart or lungs. The hollow operating tables used by Socin, Kocher, and others, which can be heated by filling them with hot water, are very serviceable for laparotomies. The Trendelenburg position is most excellent for many abdominal operations—e. g., in the pelvic region.

The peritoneal cavity is opened by dividing separately the different layers of the abdominal wall—that is, the skin, the subcutaneous adipose tissue, the fascia, the muscles, the transversalis fascia, the preperitoneal cellular tissue, and then the peritonæum. The operator seizes the separate layers of tissue with mouse-toothed forceps, the assistant does the same directly opposite, and the individual layers of the abdominal coverings are thus divided one after another. The place where the peritoneal cavity is to be opened depends chiefly upon the location of the disease. The incision is most frequently made in the linea alba. If it is necessary to divide the latter above and below the umbilicus, the latter is encircled either to the right or left—usually to the left, as it is more convenient. It is of great importance that, in division of the abdominal wall by layers, the operator should always know which layer he is dividing, and it is especially necessary to distinguish accurately the transversalis fascia and the peritonæum. A characteristic adipose tissue is found in front of the peritonæum. The latter must not be opened until the hæmorrhage from the wound in the abdominal wall has been completely arrested. When such is the case, the peritonæum is raised in the form of a fold by means of mouse-toothed forceps, and then opened. The opening is best enlarged with scissors, the forefinger being inserted underneath as a protection, or it may be done by tearing.

In order to prevent separation of the peritonæum from the edges of the wound and to protect the latter from uncleanness, it is a good plan to suture the peritonæum temporarily to the edges of the abdominal wound on both sides by a continuous catgut suture.

The further course of the operation is now determined by the nature of the lesion for which laparotomy was undertaken. The rules of asepsis must be strictly observed, and antiseptics are to be avoided in the peritoneal cavity as far as possible, as they destroy the endothelial cells of the peritonæum, and thus favour the formation of adhesions. The long-continued drying action of atmospheric air affects the endothelium in a similar way, and hence too dry asepsis is to be avoided.

Every laparotomy should be performed as quickly as possible. All unnecessary manipulations in the peritoneal cavity that consume time should be avoided, inasmuch as the shock may be dangerously increased thereby. Care must always be taken that no instruments, sponges, gauze pads, or compresses are left in the peritoneal cavity to occasion subsequent peritonitis. In a case reported by Pilate a gauze pad that had been repeatedly sterilized by steam made its way into the rectum eight months after a laparotomy. Complete recovery followed.

The abdominal wound may be sutured in various ways. The simplest method is to insert interrupted silk sutures which include the entire thickness of the abdominal wall, and then a continuous suture of catgut, by which the edges of the skin are brought into accurate apposition. Another good plan is to suture each of the different layers of the abdominal wall separately—that is, the peritonæum, the muscular layer, the fascia, and finally the skin. Schede uses silver wire that has been sterilized by boiling in a one-per-cent solution of soda. The buried silver-wire sutures remain permanently. The wound should be sutured very carefully, in order to avoid suppuration and a subsequent hernia from stretching of the cicatrix.

After insertion of the sutures the abdominal wound is covered with sterilized iodoform gauze and cotton, and the dressing is secured by sterilized gauze bandages or strips of adhesive plaster, or the line of suture is simply covered with iodoform-collodion or bichloride-bismuth paste. Regarding drainage of the peritoneal cavity, see page 39.

To prevent a ventral hernia, the patient must wear, after the abdominal wound has healed, an elastic abdominal bandage or belt.

In place of abdominal laparotomy or cœliotomy vaginal cœliotomy may be performed in suitable cases of diseased uterus and appendages, as well as of malpositions. This operation consists in opening the anterior fornix by a transverse incision, and drawing the uterus and adnexa down to the vulva.

Internal strangulation of the intestine is sometimes observed after abdominal operations, particularly in consequence of bands of adhesions. If symptoms of intestinal obstruction appear—e. g., vomiting, constipation, etc.—the abdominal cavity should be opened again as quickly as possible, and one will then proceed according to the condition of things that is found, the first indication being to free the adhesions. Laparotomy is sometimes fol-

lowed by so-called pseudo-obstruction, due merely to paralysis of the intestine, and characterized by enormous distention of the same and antiperistaltic movements in the upper part. This form is most likely to occur when the intestines are everted in the course of the operation. The increased secretion of the intestines in obstruction and pseudo-obstruction has a very important share in the formation of faeces, which is often very marked (Reichel). Pseudo-obstruction is due in part to infection of the peritonæum without visible inflammatory changes (Reichel), and in part to changes in the intestinal wall, resulting from eventration of the intestines in performing laparotomy (Olshausen). Caution should be used in giving opium and morphine after laparotomies, as internal strangulations or adhesions of the intestine are favoured by paralysis of peristalsis and constipation, or this pseudo-obstruction may occur.

In order to permit thorough palpation of the abdominal organs, Bardenheuer, Snegurieff, and others have recommended the extraperitoneal exploratory incision. The abdominal wall is divided down to the peritonæum, and the latter is then detached bluntly, so that one can palpate the abdominal organs. Bardenheuer, in particular, has suggested various incisions.

For the diagnosis and removal of retroperitoneal tumours, and for palpation of the kidney, the liver, the head of the pancreas, the duodenum, the colon, the cæcum, and the spleen, Bardenheuer recommended a lumbar incision from the eleventh rib to the middle of the crest of the ilium. If necessary, a transverse incision backward or forward, or in both directions, may be added at the upper or lower end of the longitudinal incision. Aside from this extraperitoneal exploratory incision in the lumbar region, Bardenheuer also used a semilunar incision above the symphysis for examination of the pelvic organs, and also a thoracic incision along the lower border of the ribs for detachment of the peritonæum as far as the diaphragm—e. g., in the evacuation of subphrenic abscesses.

CHAPTER XVIII.

SURGERY OF THE LIVER, GALL BLADDER, PANCREAS, AND SPLEEN.

Surgery of the Liver: Injuries (see §§ 155, 156).—Inflammations of the liver.—Abscess of the liver.—Tumours of the liver.—Echinococcus cysts.—Operative treatment of “lacing liver.”—Movable liver.—Resection of the liver.

Surgery of the Gall Bladder and the Bile Ducts: Injuries (see §§ 155, 156).—Gallstones.—Inflammations.—Tumours.—Incision and extirpation of the gall bladder (cholecystotomy, cholecystostomy, and cholecystectomy).—Cholecystenterostomy.

Surgery of the Pancreas: Anatomy and physiology.—Injuries.—Inflammations.—Hæmorrhages.—Fatty degeneration.—Pancreatic concretions.—Tumours.

Surgery of the Spleen: Function of the spleen.—Malformations.—Injuries (see §§ 155 and 156).—Inflammations.—Movable spleen.—Tumours.—Operations on the spleen: Incision (splenotomy) and extirpation (splenectomy).

§ 160. **Injuries and Inflammations of the Liver.**—We have already described injuries of the liver in §§ 155 and 156.

Abscess of the Liver.—Of the inflammations of the liver, hepatic abscess chiefly interests the surgeon. This is observed, especially in the tropics, chiefly among Europeans who have emigrated thither, who do not adapt their diet to the warm climate, make abundant use of meat and alcohol, and suffer from diseases of the gastro-intestinal tract, so that microbes are carried from here through the portal vein into the liver. According to Edwards and Watermann, dysentery is by far the most frequent cause of abscess of the liver, this being true in five hundred and twenty-four out of six hundred and ninety-nine cases; and hence the frequent presence of protozoa in the pus. It has been repeatedly assumed that abscesses of the liver may arise also from retention of bile. Abscesses proper do not arise in this way, but the tissue of the liver may, no doubt, become necrotic, in consequence of infiltration with bile, and thus give rise to actual abscesses, if the necrotic tissue becomes infected secondarily. Suppurative inflammation of the liver also occurs after open wounds of this organ with subsequent infection—e. g., after open contused wounds, stabs, or gunshot injuries; and also from extension of suppuration in the vicinity of the liver—e. g., among infants from suppurative thrombo-phlebitis of the umbilical veins. In other cases we have to do with metastatic

abscesses of the liver in the course of pyæmia. The micro-organisms may be conveyed to the liver, in case of hæmatogenous origin of the abscess, through the portal vein—e. g., in case of inflammatory processes in the distribution of the portal vein with thrombo-phlebitis and pyelo-phlebitis, and in perityphlitis and intestinal ulcers; also through the hepatic artery, and less frequently, in case of weak action of the heart and diminished abdominal absorption, through the vena cava (Th. Thierfelder). The microbes enter the capillaries of the liver, and here form, in case of pyæmic abscesses, for example, extensive colonies (Fig. 423, after Klebs). The surrounding liver cells become necrotic in proportion to the increase of the colonies of microbes in number and

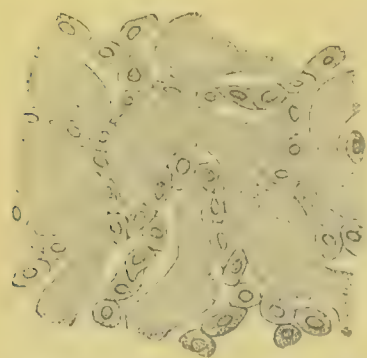


FIG. 423.—Section from the liver of a man who died of pyæmia. The capillaries between the liver cells are filled with pus cocci.

size, and this necrosis is followed by cellular infiltration chiefly in the neighbourhood of the vessels, caused by emigration of leucocytes. In this way circumscribed foci of pus are formed, which finally coalesce and form one or several abscesses. Perforation of the vessels and bile ducts gives rise to hæmorrhages and effusion of bile with corresponding jaundice.

The symptoms of abscess of the liver are very variable. Its course is sometimes very acute and sometimes chronic, lasting for months or years. The principal symptom is usually pain in the region of the liver, which often radiates toward the right shoulder, following the course of the phrenic and the fourth cervical nerves. The liver is usually enlarged at an early stage, and tender on pressure. Jaundice is present, and digestive disturbances also, with increasing emaciation. There is generally continuous fever, especially when the disease has an acute course. In cases with a more chronic course—e. g., in the tropics—the fever is inclined to be intermittent, and is frequently combined with chills. After the abscess has become adherent to the abdominal wall, the latter begins to swell and grow œdematous, and distinct fluctuation can be made out, especially in case the abscess is about to rupture externally.

It is difficult to make a differential diagnosis between single and multiple abscesses. A single abscess usually runs a chronic course, and can generally be detected on physical examination. The operation is usually the only means of making an exact differentiation.

The termination of an abscess of the liver is in most cases fatal, partly in consequence of the primary infectious disease, and partly because the abscess itself leads to pyæmia and sepsis, or ruptures into

the peritoneal cavity, the mediastinum, the pleural cavity, the lung, the pericardium, etc. Multiple abscesses have the worst prognosis. The most favourable termination is when a single abscess ruptures externally, or into the stomach and intestine, especially into the duodenum, after the liver has become adherent to the abdominal wall or to the stomach and intestine, and the peritonæum is protected from general infection by adhesions. If the abscess ruptures into the pleural cavity or the pericardium, recovery is possible also by thoracotomy or incision of the pericardium. In case it points toward the thoracic cavity, the presence of the abscess, which has at first a subphrenic location, can often be clearly made out by percussion. In other cases it is completely encapsulated in the tissue of the liver, and gradually diminishes in size from absorption and inspissation or calcification of the pus. Smaller abscesses especially may completely disappear by absorption with the formation of a cicatrix. According to Th. Thierfelder, the mortality of abscess of the liver is from seventy to eighty per cent. This high percentage has probably been lowered since the adoption of antiseptic methods in operating.

The treatment of abscess of the liver is chiefly operative, and it should be as prompt as possible. One should not wait for the abscess to become adherent to the abdominal wall or the peritonæum, or to rupture externally or into the gastro-intestinal tract. In the stage of development, especially in the cases in the tropics which have a more chronic course, Sachs recommends vesicants and calomel. Operative treatment should always begin with an exploratory puncture. The pus is then evacuated by incision or aspiration. When the presence of the abscess has been clearly made out, favourable results have been secured by performing puncture with a large trocar and allowing the canula to remain *in situ*. The canula may be advantageously replaced a few days later by a soft-rubber catheter, which is introduced into the abscess through the canula. Puncture may also be followed by aspiration or aspiration-drainage, as in empyema (see vol. ii, § 126, p. 703). Incision of the abscess, which is far preferable, is performed in one or two stages. In case the abscess is not adherent to the abdominal wall, is superficial and accessible to operation, one should take much the same course as in hydatid cysts—that is, expose the diseased part of the liver by opening the peritoneal cavity, pack the wound with iodoform gauze, and await adhesion of the liver with the parietal peritonæum; and finally, after from four to six days, make an incision into the abscess and insert a drainage-tube or gauze. If the abscess is covered by a thick layer of liver tissue, this should be divided by the thermo-cautery. If the abscess is adherent to the ab-

dominal wall, and fluctuation can be detected from the outside, it should be opened in the ordinary way by an incision. Cittle has successfully used the following method in treating abscesses of the liver, in spite of its apparent dangers: He made an exploratory puncture with a moderately large trocar through the abdominal wall. If pus was found, he pushed a knife along the canula until it entered the abscess, and an incision about eight centimetres long was made through the abdominal wall and the tissue of the liver parallel to the free border of the ribs and about two centimetres below it. Antiseptic irrigation and drainage followed, and an antiseptic dressing was applied. Abscesses of the liver are, unfortunately, in many cases scarcely accessible to surgical treatment. Abscesses that are pointing toward the pleural cavity may be evacuated through the latter by resecting the seventh, eighth, or ninth rib and cutting through the diaphragm. After an abscess has ruptured into the pleural cavity or the pericardium, thoracotomy or incision of the pericardium is sufficient (see vol. ii, § 126, page 705, and § 127, page 710). If the fever continues after opening an abscess of the liver, another abscess is usually present, and the prognosis is then unfavourable, particularly if there are several abscesses.

§ 161. **Tumours of the Liver.**—Primary tumours of the liver are, generally speaking, not common. Epithelial tumours (adenomata and carcinomata) are occasionally observed, and of the connective-tissue tumours, fibromata, fibro-neuromata as multiple, diffuse growths in the course of the sympathetic nerve, and sarcomata. All these tumours of the liver are usually but little suited for surgical treatment, and yet modern surgery has made noteworthy progress in this field also. I successfully removed a gumma of the liver as large as the fist by use of the thermo-cautery, the operation being performed at two sittings. After the peritoneal cavity was opened, the tumour, which I at first supposed to be a sarcoma, was made to heal into the abdominal wound, and the latter was kept open by packing it with iodoform gauze. After the liver had formed adhesions on all sides with the abdominal wall, the tumour was destroyed on the fifth day by means of a Paquelin cautery. The patient was permanently cured. Lücke, in a case of carcinoma of the liver, sutured the left lobe into the abdominal wound, applied an elastic ligature, and then severed it by means of a Paquelin cautery in the groove made by the ligature. The patient was still perfectly well two years after the operation, having had no recurrence. It is a very good plan to tie off the diseased portion with an elastic ligature, so as to be able to operate with as little loss of blood as possible. The extraperitoneal treatment of the wound in the liver is particularly

to be recommended on account of possible secondary hæmorrhages, such as were observed by Wagner (Königshütte) and Langenbuch after returning the liver into the peritoneal cavity. In injuries of the liver also one should, in suitable cases, on account of the danger of secondary hæmorrhages, suture the wounded portion of the liver into the abdominal wound. Bergmann, Keen, Eiselsberg, and others have recently removed tumours of the liver with success. Eiselsberg, after the removal of a cavernous angioma by means of the thermo-cautery, diminished the cauterized area somewhat in size by suture of the capsule, packed it loosely with iodoform gauze which was held in place by the sutures in the capsule, brought the gauze and sutures out at the lower angle of the abdominal wound, and returned the liver into the peritoneal cavity. In the second week the strip of iodoform gauze and the silk sutures in the capsule were withdrawn, whereupon recovery ensued.

Echinococcus Cysts.—The most common tumour of the liver is the echinococcus cyst. Other animal parasites that are found in the liver are the *distoma hepaticum*, *distoma lanceolatum*, *distoma hæmatobium*, *pentastomum denticulatum*, and *psorospermia*. These are without surgical interest, and for their exact description the reader is referred to treatises upon pathological anatomy by Birch-Hirschfeld, Ziegler, Orth, and others. We shall occupy ourselves in detail only with the echinococcus:

The *tænia echinococcus* (Fig. 424) is a parasite four millimetres long which is found in the upper part of the small intestine of the dog and has a double row of from thirty to fifty hooklets about its head. Leuckart, Naunyn, Krabbe, and others have studied the development of the *tænia echinococcus* in detail by feeding dogs with embryos from man. This worm occurs in man only in the form of a cyst. If embryos of the *tænia echinococcus* of the dog gain access to the intestines of man, they may pass from here with the chyle through the thoracic duct and the vascular system into a number of organs, most frequently into the liver, also into the spleen, the kidney, the omentum, the lung, the brain, the muscles, the bones, etc. The embryos gain access to the liver mainly through the bile passages and the portal vein. Intimate association with dogs favours the acquirement of the echinococcus. The frequency of the occurrence of this parasite in man and in animals varies in different regions. In Mecklenburg, where, according to König and Madelung, pills made from the fæces of dogs are regarded as especially efficacious against various ills, the echinococcus is particularly frequent. Birch-Hirschfeld found echinococcus twelve times in Dresden among twenty-eight hundred autopsies. In Iceland, where people live a



FIG 424.—*Tænia echinococcus*.

great deal with dogs, about one fortieth of the population, according to Krabbe, are afflicted with echinococcus cysts. Twenty-eight per cent of the dogs there have *tenia echinococcus*. They are often fed on the organs of sheep which are permeated with echinococcus cysts. The echinococcus forms in man characteristic cystic tumours which may attain an enormous size, especially in the liver. The echinococcus cyst lies in a firm capsule of con-

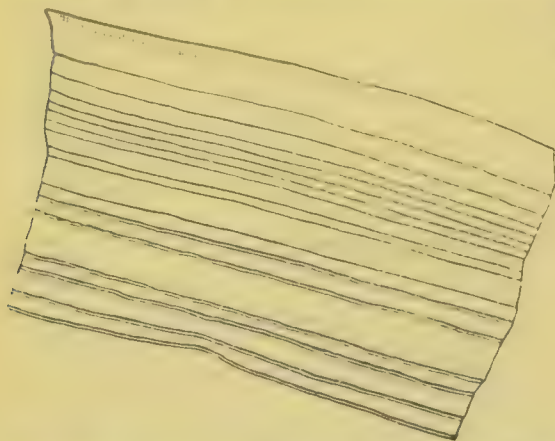


FIG. 425.—Cuticular layer of an echinococcus cyst (transverse section).



FIG. 426.—Free echinococcus scolices: *a*, retracted; *b*, protruded.

nective tissue and consists of a finely lamellated outer cuticula (Fig. 425) and an inner granulated layer called the parenchymatous layer. The so-called brood capsules are small projections of this germinal layer, and within these the scolices, with four sucking disks and the double row of hooklets, develop (Fig. 426 *b*). These scolices are at first attached to the germinal layer by a hollow pedicle, but they afterward become separated and lie free in the brood capsules. The scolices have the power of inverting the anterior part of the head into the body (Fig. 426 *a*).



FIG. 427.—Hooklets.

The echinococcus may remain single, but more frequently daughter cysts are found in the mother cyst, and the former then frequently form granddaughter cysts. If the mother cyst bursts, the daughter cysts then lie apparently free in the fibrous capsule. One sometimes finds even large cysts without brood capsules. They are then sterile (acephalous cysts). The growth of echinococcus cysts is usually slow. Their size is sometimes considerable and they may be dangerous, partly from this reason, partly from rupture into this or that cavity of the body, and partly from their location. Suppuration or sloughing of the sac may occur from bacterial infection. The echinococcus sometimes dies after a certain time, and a sort of spontaneous cure may follow from contraction of the cyst with calcification of its contents. In such cases the cysts often contain a material which is similar to that found in atheromata. The contents of the cysts consist, in addition to the scolices, of a clear fluid, free from albumin, which contains succinic acid and which is either neutral or has an alkaline reaction. Upon microscopic examination, one finds usually, though not always, scolices, single hooklets (Fig. 427), and not infrequently fragments of the characteristically lamellated cuticula (Fig. 425).

Another variety of echinococcus, called multilocular echinococcus (Vir-

chow), has thus far been observed only in the liver, and was formerly repeatedly taken for colloid carcinoma. It consists of a number of hard, white, fibrous nodules, containing cavities not larger than a pea, with gelatinous contents. Scolices are found only in a few of the same. This variety of echinococcus is not suited for surgical treatment, and we shall therefore only consider the course, diagnosis, and treatment of unilocular cysts.

Symptomatology and Diagnosis of Echinococcus Cysts of the Liver.—

Only when the cyst has reached a certain size do characteristic symptoms appear such as to render the diagnosis possible. One then finds in typical cases a soft, fluctuating tumour in the region of the liver which usually causes the patient but slight discomfort. So long as the cyst is not adherent to the abdominal wall, it rises and falls with the respiration, following the movements of the diaphragm. The so-called hydatid thrill is sometimes present; this is obtained by striking the elastic, fluctuating tumour with one hand, and placing the other hand some distance from it, whereupon one feels a peculiar thrill or vibration, supposed to be caused by the motion of the separate cysts. This hydatid thrill is often absent, however. Jaundice is very frequently wanting. It arises usually from compression of the bile ducts. Other symptoms are a feeling of pressure in the region of the liver, interference with respiration corresponding in degree to the size of the tumour, and digestive disturbances resulting from pressure upon the stomach and the intestines. With increasing growth a corresponding destruction of the tissue of the liver ensues, but there often occurs a compensating hypertrophy in the sound parts of the organ. As was mentioned above, the brood capsules in the cyst may die in exceptional cases—e. g., from the entrance of bile into the sac. Spontaneous or traumatic rupture of the sac with effusion of the cyst contents into the peritoneal cavity may cause an extensive development of cysts; this may also occur from rupture of the sac into the blood and lymph vessels, particularly into the vena cava. We have already mentioned above the possibility of perforation of the stomach, the intestines, or the thorax (pleura, lung, pericardium, mediastinum), as well as the occurrence of suppuration and sloughing of the sac from microbic infection.

The diagnosis of echinococcus of the liver—which, especially in case of a deep location in the substance of the organ, is sometimes difficult or impossible—is best determined by an exploratory puncture with an aseptic aspirating syringe. One then generally obtains, as was mentioned above, a clear fluid, free from albumin, rich in sodium chloride, and containing succinic acid, in which, when microscopically examined, there are usually found, though not always, scolices and hooklets, often

in large quantities. As to the differential diagnosis between echinococcus and tumours of the kidneys, hydronephrosis, etc., the reader is referred to the surgery of the kidney.

The treatment of echinococcus of the liver is operative. The best plan is, in all cases in which the cyst is as yet not adherent to the abdominal wall, to perform the operation at two sittings—that is, first to expose the cyst wall by laparotomy in the region of the liver, then to bring about adhesions between the cyst or the surface of the liver and the abdominal wall by packing the abdominal wound with iodoform gauze, and finally, after from six to twelve days, to open it with the knife or the thermo-cautery, evacuate its contents, scrape it out, irrigate and drain it. Before or after the incision the wall of the cyst may be secured in the wound by a few sutures. Finally, in the course of several weeks, the cyst gradually shrivels up with or without expulsion of its wall. The wall of the cyst sometimes becomes loosened very soon, so that one can remove it *in toto* through the wound by means of the hand or dressing forceps. During the after-treatment the cyst should be cautiously irrigated with boric acid or bichloride (1 to 5,000) and the irrigation fluid removed completely.

In all cases in which the cyst is adherent to the abdominal wall it should be incised and drained at one sitting. Hydatid cysts have also been incised from within the thoracic cavity—e. g., in case of a subphrenic location, by opening the thoracic cavity in the axillary line between the fifth and sixth ribs, and then, after resection of a piece of the rib, cutting through the diaphragm and into the tumour, which is pressing against the thoracic wall and pushing the diaphragm upward (Volkmann, Israel, Leyden). Israel performed the operation at three sittings. P. Bruns successfully extirpated a hydatid cyst by resection of a portion of the right lobe of the liver.

Other methods of operating upon echinococcus of the liver are in part dangerous and in part uncertain in their results. Lindemann and Landau recommend operation at one sitting for all cases. After opening the peritoneal cavity, Lindemann sutures the parietal peritonæum to the outer skin of the abdominal wound, then inserts two strong sutures of catgut through the sac parallel to the laparotomy wound, and by means of these draws the sac into the abdominal wound so that it can be opened between them. The wall of the cyst is then sutured into the abdominal wound. Landau, after performing laparotomy, empties the sac in part by means of Dieulafoy's aspirator (see Principles of Surgery, p. 70, Fig. 51). After partial evacuation and relaxation of the sac, the latter is incised and sutured to the abdominal wound.

Puncture of the cyst, with or without injection of iodine, is uncertain and dangerous because suppuration of the sac may follow, and further scattering

of echinococcus infection is possible from escape of the contents of the cyst into the peritoneal cavity; and in case the contents are already purulent, acute peritonitis may result. Simon's double puncture, which consists in piercing the sac with two long, fine trocars, is an old method, and has been abandoned. Récamier, Bégin, and others brought about adhesions of the echinococcus sac with the abdominal wall by means of caustics—e. g., by applying a paste of chloride of zinc. The caustics were, according to their nature, either applied directly to the skin, or, better, to a wound made nearly down to the peritonæum. This method is also obsolete.

Of other cysts of the liver, I mention those in particular which arise from constriction of bile ducts. Subserous cysts as large as the fist or a child's head even may arise, according to Recklinghausen, from gradual dilatation of the vasa aberrantia of the bile ducts and retention of the secretion of the mucous glands. Finally, lymph cysts develop from obstruction to the flow of the lymph (lymphangeiomata), and sanguineous cysts from varicose tumours or angeiomata.

Operative Treatment of "Lacing Liver."—Movable constricted portions of the liver, due to tight lacing, sometimes occasion severe pain. Billroth, Hacker, and Tscherning have relieved the pain by suture of the constricted lobes (hepatorrhaphy). Langenbuch removed successfully a constricted left lobe of the liver by tying off the bridge of connective tissue in several portions. The piece of the liver which was removed weighed three hundred and seventy grams.

Ponfick removed a quarter of the liver from rabbits and dogs without injury to the animals, and even by resection of half or three quarters of the liver their life was in no wise endangered. The animals experimented upon survived the removal of the entire liver but a few hours. In all cases of successful liver resection (up to from one half to three quarters of the organ) a vigorous new growth of liver tissue immediately followed the operation. After less than a month this restoration of the liver tissue is to be regarded as completed. The loss to the organ may then have been not only recovered but more than compensated for. Atrophy of a portion of the liver in consequence of obstruction to the flow of bile is followed by hypertrophy of those portions in which the bile is not obstructed. Nasse has also proved this experimentally.

§ 162. **Surgery of the Gall Bladder and Bile Ducts.**—For injuries see §§ 155, 156. Of the diseases of the gall bladder and the bile ducts the formation of gallstones is the most important from a surgical point of view.

Gallstones are partly round, partly oval, often faceted formations of very varying size—e. g., as large as a millet grain, a hazelnut, a walnut, or even a hen's egg. They are usually of a yellowish-brown or blackish-brown colour. Their number may be very large. I removed, for instance, three hundred and two gallstones from the gall bladder and the cystic duct of a woman fifty-five years of age. Gallstones most frequently consist of cholesterine, bile pigment, magnesium salts, and calcium carbonate. Stones consisting of bilirubin and calcium carbonate or biliverdin and calcium carbonate are rare

and usually small. Still more rare are the stones composed of calcium carbonate alone. The following kinds of gallstones have been distinguished: 1. Crystalline gallstones, which consist almost entirely of cholesterine and are but slightly pigmented. 2. Amorphous gallstones of smooth, yellowish-white appearance, with a saponaceous lustre, and made up of separate layers. They are the most common, and consist chiefly of cholesterine. 3. Gallstones which consist of alternating layers of cholesterine and bile pigment. 4. The above-mentioned bilirubin-calcium and biliverdin-calcium stones and those composed of calcium carbonate alone.

Gallstones are formed by far the most frequently in the gall bladder, less often in the bile ducts. They arise from retention and decomposition of the bile, and their formation is favoured by inflammatory processes in the bile ducts and in the gall bladder, by portal congestion, and by general anomalies of nutrition. Many persons are strongly predisposed to the formation of gallstones. Their frequent occurrence among females is explained, according to Marchand, by tight lacing and the resulting compression of the gall bladder, and particularly of the cystic duct.

The clinical course of cholelithiasis, or stone formation in the gall bladder and bile ducts, is characterized by attacks of severe pain (biliary colic) when larger gallstones pass through the cystic or common duct or become impacted. Severe symptoms of peritoneal irritation with tympanites, extreme tenderness of the peritonæum and marked swelling of the liver with retention of bile, are sometimes observed, so that one is tempted to resort to laparotomy. The threatening symptoms may then disappear very suddenly, and a rapid improvement in the general condition immediately follows when the obstruction to the escape of the bile, the gallstone, passes into the intestine or into the gall bladder. If the discharge of bile from the liver is permanently and completely obstructed by a firmly impacted gallstone, death may ensue from slowly increasing marasmus in consequence of an excessive amount of bile in the blood (cholæmia). The small gall ducts in the liver are gradually dilated as the result of continued retention of bile, and the liver cells undergo a corresponding degeneration. An inflammatory proliferation of the interstitial connective tissue develops more and more as the retention of bile continues. When the passage of bile into the intestine is obstructed, the fæces are whitish-gray or clay-colored. Floating kidney is comparatively often observed in connection with gallstones, with enlargement of the liver caused by retention of bile. This affection varies in degree, and is due to the fact that the kidney is forced downward by the enlarged liver. Suppurative inflammation of the liver and empyema of the gall bladder may arise as the result of decomposition of the bile, especially after the importation of microbes through the blood channels, the lymph passages, or the intestines. If the pus ruptures into the peritoneal cavity, acute fatal peritonitis is then possible. The gall bladder is often so tensely filled with stones that it can be distinctly felt through the abdominal wall in the form of a tumour at the lower border of the liver. Pressure of the calculi and suppurative inflammation in consequence of the entrance of pus microbes may give rise to gangrenous cholecystitis and perforation of the gall bladder.

The migration of gallstones is of especial interest. Their passage from the liver into the common duct is easily understood, but their migration

from the gall bladder, where they most frequently develop, into the cystic duct and on into the intestine is more difficult to comprehend. After the gall bladder has become distended the stone is probably forced into the neck of the bladder and then into the cystic duct by the pressure of the bile that has collected and by strong contractions of the gall bladder, especially during the attacks of colic. The stone often remains lodged in the cystic or the common duct, particularly at the narrowest place at Vater's diverticulum, before entering the intestine. It is gradually forced into the duodenum by the pressure of the bile behind it, and is finally discharged *per rectum*. If a superficial ulceration of the common duct arises from a stone that has been impacted for some time, complete closure of the duct may occur after the gallstone has made its way into the intestine. Calculi sometimes make abnormal passages for themselves by perforation or by rupture of the bile ducts and enter the stomach, the intestine, most frequently the duodenum, rarely the colon, and in rare cases also the portal vein, the urinary passages, the peritoneal cavity, or they come out through the abdominal wall. In case of unusually large stones in the intestine, death may ensue from obstruction or perforation of the latter.

A biliary calculus which has remained in the intestine for a considerable time without causing serious symptoms may suddenly become firmly incarcerated by an attack of colic. This gives rise to severe pain, the irritated intestine grasps the foreign body more and more firmly, and permanent obstruction follows, with faecal vomiting. The prognosis of this form of intestinal obstruction is more favourable than formerly; out of five patients that were operated upon, four recovered (Körte). The treatment consists in laparotomy and removal of the calculus by opening the intestine; the intestine is then sutured.

Inflammations of the Gall Bladder.—Cholelithiasis is not infrequently complicated by inflammations of the gall bladder, especially dropsy and empyema. Dropsy of the gall bladder is conditioned essentially upon an accumulation of the secretion of its mucous glands, which occurs especially in connection with stone formation with obstruction of the cystic duct. Under such circumstances the gall bladder may attain the size of the fist. The location of the circumscribed tumour at the lower border of the liver is especially important for the diagnosis of this condition, and also the fact that the tumour rises and sinks with the liver during respiratory movements. The tumour is sometimes more or less covered by coils of intestine.

Empyema of the gall bladder resulting from microbic infection is usually accompanied by fever and extreme inflammatory symptoms. In abscess of the gall bladder that has a more chronic course there is often a complex of symptoms similar to that which attends dropsy—that is, fever and inflammatory symptoms may be more or less absent. An empyema of the gall bladder, especially when gallstones are present, may attain a very large size (Kocher, König). It may rupture externally through the abdominal wall by preference in the umbilical region or into the intestine, after the gall bladder has formed adhesions with the parts named. A biliary fistula discharging through the abdominal wall or into the intestine may then be the result. Several large gallstones are usually found in such cases in the gall bladder, and after their removal the fistula generally heals.

Marked contraction and induration often attend chronic inflammations of the gall bladder, so that no more bile can flow into it. Its contents sometimes thicken in such cases and form a firm mass, which may completely calcify. Ulcerative processes frequently develop on the inner wall of the bladder sometimes with perforation. Operative measures are always indicated in empyema, but in dropsy only when there is pain.

Very severe colic may be occasioned by cicatricial bands and adhesions of the gall bladder. Gallstones are usually present in such cases, but they may be absent. The pain is relieved by laparotomy and separation of the adhesions. To avoid recurrence, the wound surfaces arising from freeing the adhesions are sutured as far as possible.

The Treatment of Biliary Calculi belongs at the outset in the province of internal medicine. It consists especially in treating the attacks of colic with narcotics (opium, morphine, belladonna, chloroform, warm baths, etc.), and then in removing the predisposition to cholelithiasis by a general medicinal treatment suited to the case—diet, suitable mode of life, cathartics, Carlsbad, etc.

The surgical or operative treatment of cholelithiasis is only indicated when serious disturbances exist which do not yield to internal treatment. It is especially necessary when there is continued retention of bile or very severe pain or increasing marasmus with severe jaundice, or, finally, when threatening symptoms appear in consequence of perforation of the bile passages or the intestine, etc.

Operations on the Gall Bladder.—The radical operation for biliary calculi is either incision (cholecystotomy) or extirpation of the gall bladder (cholecystectomy). In by far the larger number of cases gallstones are formed in consequence of retention and decomposition of bile. Only in exceptional cases do they develop in the liver or in the larger bile passages, the hepatic, the cystic, or the common duct. Langenbuch deserves great credit for his work in connection with the surgery of the gall bladder. He was the first who performed its extirpation successfully, and since then the operation has been undertaken repeatedly with good results.

The technique of extirpation of the gall bladder is as follows: As in every laparotomy, the peritoneal cavity is opened with the strictest observance of asepsis. The opening is made over the tense gall bladder, which can usually be distinctly felt, either by a longitudinal incision below the free border of the ribs, beginning near the end of the tenth costal cartilage and following the lateral edge of the rectus muscle, or, better, by an angular incision, after Czerny. In the latter case the vertical incision runs in the linea alba, and the horizontal incision to the right, just below the umbilicus. In a case in which I successfully extirpated the gall bladder for stone formation the liver could be

displaced far enough toward the median line beneath the very lax abdominal wall to allow the incision to be made in the linea alba above the umbilicus. After opening the cavity the liver is drawn upward by means of a strong silk suture that is passed through it or by means of sharp retractors, so that one can get a good view of the posterior surface. After double ligation of the cystic duct with silk or catgut and division of the same between the ligatures, the gall bladder is detached from the liver with the fingers by blunt dissection. Another way is to first detach the gall bladder from the liver, and then, after double ligation of the cystic duct, to divide the latter between the ligatures. Any hæmorrhage from the liver is arrested by compression or by the thermo-cautery. The cystic and the common ducts should then be carefully examined to determine whether there may not be an impacted calculus. If such is found it should, if possible, be pushed on into the intestine or crushed with the fingers or forceps (cholelithotripsy, Kocher, Robson). Cholelithotripsy may also be employed in connection with cholecystotomy. One may remove a stone impacted in the common duct in suitable cases by incision of the latter (choledochotomy) with subsequent suture. Choledochotomy will probably be more and more resorted to in the future in such cases as a substitute for cholecystenterostomy (see page 63). After the extirpation has been completed the peritoneal cavity is closed again in the way described on page 47.

The objections have been made to extirpation of the gall bladder that the operation is dangerous and that the ligated cystic duct may easily open again later from the pressure of the secreted bile, and that a fatal biliary fistula could then be formed. These objections are, in my opinion, not altogether justified, especially the latter, as experience thus far has shown. The operation always involves danger to life, and should therefore be resorted to only in extreme cases. Removal of the gall bladder has in itself no evil consequences, as has also been shown by experiments on animals (Nasse).

Incision of the gall bladder (cholecystotomy) in place of its extirpation has been recommended especially by Lawson Tait, Kocher, Trendelenburg, König, Küster, Riedel, Czerny, Körte, and others. It is performed in various ways. One may operate much as in dealing with a hydatid cyst—that is, after the peritoneal cavity has been opened by means of the longitudinal incision described on page 60, or by an angular incision, the gall bladder is sutured into the abdominal wound and then incised and drained after removal of the stones (cholecystostomy). In suturing the gall bladder into the abdominal wound the former may easily tear, as I saw it do in one case. I closed the

rent by means of an artery clamp which was left in place, and the gall bladder was then sutured into the wound in the usual way. I closed the latter in part by suture and packed the remainder, where the gall bladder lay adjacent, with iodoform gauze. Four days later the gall bladder had become adherent on all sides with the abdominal wound, and it was now incised and numerous stones were removed by means of a sharp spoon and by irrigation. This method of operating in two stages is also serviceable in empyema of the gall bladder in case one does not here choose the extirpation of the latter after it has been evacuated by puncture or by careful incision.

Czerny in particular has recommended cholecystotomy in one sitting, with subsequent suture of the wound in the gall bladder into the abdominal incision (cholecystostomy). In this way the gall bladder and the gall ducts are more accessible and calculi are more easily removed. In dropsy of the gall bladder its incision in one or two stages with subsequent drainage is likewise indicated.

After incision and drainage of the gall bladder an external biliary fistula often persists, which usually, however, causes no discomfort.

Küster recommended incision of the gall bladder, with subsequent suture and reposition of the bladder. After suture of the incision the gall bladder may be fixed in the abdominal wound by way of precaution. I have performed it once successfully. Senger and Wölfler employed this method in two stages with good results—that is, they first opened the gall bladder which was attached in the abdominal wound, and then a few days later detached it again, sutured the opening, and then dropped it back into the peritoneal cavity. This method is contra-indicated in case the discharge of bile into the intestine is interfered with and in case of suppurative inflammation of the bladder. Zielewicz recommended for suitable cases cholecystotomy, with ligation of the cystic duct. In case an external biliary fistula persists after cholecystostomy, a soft bougie or catheter may be passed into the bile ducts to ascertain the possible existence of an obstruction in the cystic or common duct.

In every operation for biliary calculi the cystic duct should be palpated. If a stone is found it should be removed by suitable instruments or pressure with the finger, and if impacted should be cut down upon (cysticotomy) and the incision closed by a continuous suture. This cysticotomy should always be combined with cholecystostomy.

Regarding the choice between the two methods of operation—extirpation and incision—I am of the opinion that one should decide each case by itself. Incision of the gall bladder has recently, as compared with extirpation, gained more and more adherents. I agree with Czerny in the opinion that

the ideal operation for gallstones consists in incision, evacuation, and suture of the gall bladder, after which the abdominal wound is to be drained for a short time. If the cystic duct is not patent, or if the gall bladder is inflamed, the formation of a temporary external fistula (cholecystostomy) is to be recommended. Cholecystectomy is indicated in case of severe inflammatory or carcinomatous degeneration of the gall bladder.

Cholecystenterostomy.—In cases of permanent closure of the common duct by firmly impacted gallstones, tumours, inflammatory processes, or adhesions, Nussbaum first recommended the establishment of a connection between the gall bladder and the upper part of the jejunum, in order to render the discharge of bile into the small intestine possible, and to prevent death from cholæmia or from rupture of the gall bladder.

Cholecystenterostomy is performed as follows: The peritoneal cavity is opened by means of an angular incision (see page 60), or one along the outer border of the right rectus muscle. Then follow incision of the gall bladder, opening of the intestine (jejunum), and union of the opening in the gall bladder and that in the intestine (continuous inner suture of the mucous membrane, continuous external suture of the serous membrane in two rows). By using Murphy's button the operation is very much shortened. If the gall bladder is long enough, a communication is made between the gall bladder and the duodenum (cholecysto-duodenostomy). In some cases of closure of the common duct the question may be considered of uniting the passable part of the common duct with the duodenum (choledcho-duodenostomy).

In operations upon the gall bladder one should always be on the lookout for any adhesions of the same that can be removed. They are not infrequently the cause of very severe colic (see page 60).

Tumours of the Gall Bladder.—Carcinoma of the gall bladder in the form of soft growths on its inner surface has been most frequently observed. It is either primary or secondary to carcinoma of the liver. It is interesting to note that, in connection with carcinoma of the gall bladder, biliary calculi are found almost without exception. This is true, according to some authors, in from 91 to 95·4 per cent of all cases. The calculi give rise to chronic inflammatory irritation of the inner surface of the gall bladder, and the carcinoma finally develops on top of this. Calculi are much rarer in case of secondary (metastatic) carcinomata of the gall bladder. In primary carcinoma extirpation of the gall bladder is indicated, but most cases are not diagnosed until the disease has already attacked the liver.

Congenital absence of the gall bladder has been observed in rare cases, and does not usually give rise to special disturbance. Besides one of his own, Eshner collected fourteen cases, some of which should undoubtedly be excluded, as in these the obliteration of the gall bladder resulted from inflammatory processes later in life.

§ 163. **Surgery of the Pancreas.**—The literature touching upon the surgery of the pancreas is as yet very scanty. Senn has recently made the attempt to place the surgery of this organ upon a solid footing by experimental investigation and by collecting the illustrative cases of which there is record.

The pancreas, which has a retroperitoneal location behind the stomach, is an acinose gland with small, longish, club-shaped acini. The posterior surface of the pancreas rests upon the spinal column and against the aorta and vena cava. It covers with its lower border the beginning of the superior mesenteric artery and the termination of the vein of the same name. The right extremity of the gland is called its head, the left its tail, and the middle part is the body. The pancreas is attached to the peritoneum by means of connective tissue, and is visible through it. The secretion of the pancreas passes through an excretory duct of its own, which in man usually empties into the duodenum in conjunction with the common bile duct. The position and orifice of the pancreatic (or Wirsung's) duct vary greatly in different animals. The duct begins with small branches in the left end of the gland and passes through its entire length, gradually increasing in size. The gland does not secrete continuously, but only during digestion. The secretion begins upon the entrance of food into the stomach, probably in consequence of reflex stimulation through the nerves of the stomach and the duodenum. It then gradually increases for the first two or three hours, then diminishes again, and increases once more, from six to eight hours later, upon the passage of the fluid material into the duodenum. The secretion then gradually diminishes again, and ceases entirely after the completion of digestion. The secretion of the pancreas, which has a strong alkaline reaction, contains chiefly three ferments: 1. Pancreatin, which converts starch into sugar. 2. Trypsin, which converts albumin into peptones. 3. A ferment by which neutral fats are broken up. It also contains albumin, leucin, xanthine, guanine, and, of inorganic ingredients, carbonate of lime, phosphate of lime, alkalies, earths, and, upon the addition of acetic acid, a little carbonic acid. Although the secretion of the pancreas plays so important a part in the economy of the human and animal organism, still cessation of the function of the pancreas—e. g., by ligation of the pancreatic duct in dogs—is comparatively well borne (Parlow, Martinotti). In man also marked pathological changes are sometimes found in the pancreas without any corresponding symptoms having shown themselves during life. A frequent concomitant symptom attending atrophy of the pancreas is diabetes mellitus, which is often combined with fatty stools.

In diagnosing affections of the pancreas, special stress should be laid upon incomplete digestion of fat and starch, and the existence of diabetes and fatty stools, and for this reason the urine and feces are to be carefully examined. The urine also contains fat in some cases.

An accessory pancreas is sometimes found in the form of a gland lobule, which may be as large as a silver dollar. It is usually situated in the wall of the upper part of the small intestine or the stomach, and has an excretory duct leading into the intestine. Division of the pancreas into two equal or

unequal parts, each provided with an excretory duct, has been observed, as well as absence of the organ.

Injuries of the Pancreas are rare in consequence of its protected location. Other abdominal organs are usually injured at the same time, especially the liver, the stomach, the intestines, or the large abdominal vessels, and death follows in consequence of these associated injuries, without any apparent symptoms of a rupture of the pancreas. In the thirteen cases as yet known of injury of the pancreas, there was, according to Senn, no characteristic symptom present. Death resulted mainly in consequence of the associated injuries of other organs of the peritoneal cavity. Contusion or rupture of the pancreas is not of itself an injury that endangers life, as Senn showed experimentally, and recovery is possible. The hæmorrhage attending incised wounds is more severe than that attending contusion and rupture. If parts of the pancreas lose their connection with the intestine, they undergo atrophy. Prolapse of the pancreas through an abdominal wound has sometimes been observed, an occurrence that is questioned by Hyrtl and Klebs, on the ground that it is impossible, but which is confirmed by Nussbaum and Senn as having actually taken place. Laborderle, Dargeau, Kleberg, Wagner, Thompson, and Cheever have reported penetrating abdominal wounds with prolapse of the pancreas. In all the cases except Cheever's (gunshot wound, peritonitis) the patient recovered, and Nussbaum rightly states that the peritoneal cavity is protected from secondary infection by the prolapse of the pancreas. This complication is conditioned upon the severing or loosening of its connections, and may occur some time after the injury, being induced by coughing, crying aloud, vomiting, or contraction of the abdominal muscles during defecation. In such cases the mesentery of the duodenum has frequently been found to be very long. It is known, also, that the pancreas has occasionally been displaced into the thoracic cavity within a diaphragmatic hernia, and in a case reported by Bandl it was drawn down into an intestinal intussusception.

Treatment of a previously diagnosticated injury of the pancreas will seldom be possible. If it is found, in performing laparotomy for an abdominal injury, that the pancreas is contused, the contused portion should be removed after tying it off with aseptic silk or catgut. In case of prolapse of the pancreas through an abdominal wound, the condition of the prolapsed gland is first of all to be considered. If not contused or inflamed, it should be disinfected and put back into the peritoneal cavity. One may also, as in a case reported by Wagner and Kleeberg, for example, which had a favourable course, suture the prolapsed pancreas into the abdominal wound after the prolapsed por-

tion has been tied off and removed. After the tied off portion had come away, complete recovery followed. In case of severe contusion of the organ with already existing gangrene, or in case it is inflamed, the pancreas should be drawn still farther out of the wound, a ligature applied about it where the tissue is sound, and the contused or inflamed part removed. One may then suture the organ into the abdominal wound, or, in case the remaining part of the pancreas is aseptic, return what is left into the abdominal cavity. Complete extirpation of the pancreas is to be avoided as far as possible. Partial extirpation is simplest, with preservation of the excretory duct. Complete extirpation easily proves fatal from injury or gangrene of the duodenum arising from too extensive detachment of the mesentery. After partial removal of the pancreas, the part that remains connected with the intestine preserves its normal structure and its functional activity. The part that is severed from the intestine and the rest of the gland undergoes degeneration and sclerosis.

Even when the pancreatic juice is wholly absent, digestion is, in man, not seriously disturbed. The transformation of starch into glucose is carried on by the intestinal digestive fluid, and the emulsion of the fat by the bile. Birds alone die very soon after extirpation of the pancreas, usually within eight or ten days, of increasing marasmus (Claude Bernard).

Experimental Investigations regarding Injuries to and Operations upon the Pancreas.—Mering, Minkowski, and Senn have performed partial and complete extirpation of the pancreas in cats and dogs, and carefully studied the course of the injuries. The pancreas was exposed in the animals named by opening the peritoneal cavity in the linea alba from the xiphoid cartilage to the umbilicus and displacing the omentum upward or tearing through it. The pylorus and duodenum were then looked for, and after the duodenum had been followed for eight or ten centimetres with the forefinger, it was seized with the thumb and forefinger and drawn, with the head of the pancreas, into the wound, and the pancreas was bluntly separated from the duodenum.

In case of transverse wounds or entire division of the pancreas, Senn secured complete healing without disturbances by carefully arresting the hæmorrhage and suturing the organ under antiseptic precautions. In case of complete division, obliteration of the pancreatic duct at the site of the injury always follows, and parenchymatous degeneration and atrophy of the part of the pancreas located beyond. Any part of the pancreas that is separated from the intestine and deprived of its blood supply may disappear by aseptic absorption, leaving no trace. The tissue of the gland, however, and the pancreatic juice decompose very easily. They are a very favourable nutritive medium for microbes, for which reason all operations on the pancreas are to be performed under the strictest observance of anti-

septic precautions. The pancreatic juice does not of itself cause peritonitis if it gains access to the peritoneal cavity through an internal pancreatic fistula or in consequence of injuries. The wounds and contusions of the pancreas are the most dangerous when near the intestine, especially wounds of the pancreatic duct where it empties into the intestine. Death from general peritonitis, caused by infection from within the intestine, may easily result in such cases. We have already mentioned that the suspension of the pancreatic digestion is borne without disturbance by men and mammals, but not by birds; and this was proved earlier in numerous experiments by Schiff, Claude Bernard, Colin, and others. Upon ligation of the pancreatic duct after it leaves the gland, the secretion continues for some time with corresponding dilatation of the duct and accumulation of secretion in the gland (Heidenhain); but the secretion is finally absorbed and excreted by the kidneys (Kühne). Retention cysts are most likely to occur when the secretion thickens and becomes incapable of absorption.

As already mentioned, complete extirpation of the pancreas always terminated fatally in Senn's experiments from injury or gangrene of the duodenum, resulting from too extensive detachment of the mesentery. Partial removal of the pancreas, with limited detachment of the mesentery from the duodenum, caused no disturbance. In contradistinction to Senn, Mering, Minkowski, and Martinotti have successfully performed complete extirpation of the pancreas in dogs, which are more suited to the operation than cats. The dogs gave no signs of disturbances beyond a striking greediness and diabetes. We have already mentioned that ligation of the pancreatic duct is also well borne by dogs.

Inflammations of the Pancreas are rare, being most frequent after traumatisms, and as secondary affections from metastasis or the extension of inflammation of the neighbouring organs. Acute pancreatitis is extremely rare, occurring sometimes in the course of infectious diseases—typhoid fever, for example—and it is either an interstitial inflammation or takes the form of a parenchymatous degeneration. The inflammation is sometimes combined with hæmorrhages (see page 70). Acute pancreatitis results from the entrance of microbes into the pancreatic duct from within the duodenum, especially after hæmorrhage. Such extreme obstipation not infrequently attends acute swelling of the pancreas that an internal strangulation may be suspected (R. Fitz). Complete intestinal obstruction has been observed also in consequence of the pressure of a tumour of the pancreas, especially a carcinoma or a hæmatoma. Suppurative pancreatitis chiefly interests the surgeon. It may begin primarily in the inter-acinous connective tissue—e. g., after penetrating injuries, after the access of pyogenic micro-organisms by means of the blood or lymph channels, or by direct infection from within the intestine, just as suppurative parotitis results from microbic infection from within the mouth. In other cases suppurative pancreatitis arises secondarily

from the extension of a peripancreatic abscess that develops in the course of pyæmia; also from inflammations in the bursa omentalis or in the neighbourhood of the bile ducts, from an ulcer of the stomach, with rupture in the direction of the pancreas, from a retroperitoneal abscess, etc.

The symptoms of suppurative pancreatitis or abscess of the pancreas are as follows: In a perfectly well person, or after previous disturbances of the digestive organs, vomiting, epigastric pain, great prostration, and distention of the abdomen make their appearance, usually accompanied by constipation. During the acute stage it may be mistaken for poisoning, gastro-duodenitis, hepatic colic, peritonitis, intestinal obstruction, etc. The acute stage, particularly in the hæmorrhagic form, may result in death from collapse, or it goes on to a subacute or chronic course. The patients die of pyæmia, with digestive disturbances, diarrhœa, evacuation of pus *per anum*, and jaundice or a bronzed skin. According to Körte and Chiari, recovery took place in two cases after elimination of the gangrenous pancreas *per rectum*. In subacute cases it is of chief importance for the diagnosis that a tumour can usually be felt in the epigastrium between the stomach and the transverse colon somewhat to the left side, or in some cases more in the left lumbar region. The pus which has formed near or in the pancreas may rupture into the general peritoneal cavity, the stomach, the intestine, or into the bursa omentalis, and may become encapsulated in the latter; it may also burrow behind the peritonæum, on the left side behind the descending colon, more rarely on the right side, and, furthermore, down along the spinal column between the layers of the transverse mesocolon or of the mesentery.

The diagnosis of an abscess of the pancreas is always difficult, and in most cases one supposes that he has to deal with a lesion of the stomach or the liver. From a diagnostic standpoint, importance should be attached to the characteristic onset, followed by the appearance of an epigastric tumour that can be felt, particularly on inflation of the stomach and intestines, or of a lumbar swelling on the left side; furthermore, to the progressive anæmia and loss of flesh, and to the examination of the fæces. As a rule, the patients are alcoholic. An exploratory puncture is dangerous, and should only be resorted to in case of burrowing of pus behind the peritonæum. The pus contains a large amount of fat, numerous pus cocci, and not infrequently intestinal bacilli (Körte).

The prognosis of abscess of the pancreas is unfavourable. Death usually results from sepsis or pyæmia, or in consequence of rupture into the peritoneal cavity, with acute general peritonitis. Recovery

has repeatedly been observed after the abscess had perforated the stomach or intestine.

Gangrene or necrosis of the pancreas sometimes follows its acute inflammation. Senn has collected several cases which were observed by Rosenbach, Prince, Chiari, and others. Israel saw gangrene of the pancreas in connection with diabetes mellitus, and Trafoyer and Rokitsky after intussusception of the duodenum, into which the pancreas was drawn. In several cases of gangrene of the pancreas a large gangrenous cavity was found with closure of the small intestine, in consequence of pressure upon the same, so that during the life of the patient primary intestinal obstruction had been diagnosticated. These cases show that in case of operation for intestinal obstruction one should think also of the possibility of inflammation, abscess, gangrene, and tumour of the pancreas (see also page 74).

Chronic Inflammations of the Pancreas.—Of chronic inflammations of the pancreas, interstitial pancreatitis, cirrhosis, or sclerosis of the pancreas may be mentioned first, which results from an increase, hardening, and consolidation of the interstitial connective tissue, with atrophy of the glandular elements, and sometimes with stricture of the duct and corresponding distention of the same beyond the constriction, on account of the accumulation of secretion. In this way retention cysts may arise. In case of complete and permanent closure of the duct, atrophy and degeneration of the gland ensue. The causes of this sclerosis of the pancreas are often unknown. It is sometimes observed in connection with pancreatic concretions, especially among alcoholic individuals. It usually arises, no doubt, from the extension of analogous affections in the neighbouring organs. The chief symptom in this chronic, sclerotic pancreatitis is digestive disturbance resulting from defective secretion of the pancreatic juice. The discharge of bile is also sometimes disturbed by cicatricial contraction. In case of impaction of a calculus at the same time in the pancreatic duct, severe pain may ensue, as in biliary colic.

Syphilitic and tubercular diseases of the pancreas are very rare. Tuberculosis of the pancreas is occasionally found, especially in connection with general miliary tuberculosis. It develops, as a rule, from tubercular foci in the lymph glands in the neighbourhood of the pancreas. In extremely rare cases primary tuberculosis of the pancreas has been observed. Hartmann mentions a case in which the pancreas had wholly disappeared and was replaced by cheesy masses.

The Treatment of Suppurative Pancreatitis.—Of all the above-mentioned inflammations of the pancreas, only suppurative pancreatitis, abscess of the pancreas, suppurative peripancreatitis, and gangrene of the pancreas are suited to surgical treatment.

In case of suppuration, incision and drainage are indicated. The incision through the skin should be made, generally speaking, where the abscess is nearest to the abdominal wall, and the peritoneal cavity

opened from in front or from behind. Access to the pancreas from in front may be difficult on account of dilatation of the stomach. In such cases the stomach has to be drawn upward. The omentum is divided with the fingers, whereupon the transverse colon is drawn downward, the duodenum exposed, and the pancreas is found behind the same. In case of very large abscesses the wall of the abscess will, if possible, be sutured to the abdominal wound, and then incised and drained. If the abscess is small it is difficult to suture it into the abdominal wound, and one may then open it directly, and, after disinfection of its cavity, drain it posteriorly in the lumbar region. In suitable cases the pancreas may be exposed from behind in the lumbar region on the right side of the spinal column, especially in case of a retroperitoneal peripancreatic abscess. It must be kept in mind hereby that the posterior surface of the pancreas rests upon the aorta and the vena cava, and that it covers with its lower border the origin of the superior mesenteric artery and the termination of the vein of the same name. In case of gangrene of the pancreas, essentially the same course will be pursued as in dealing with an abscess. Out of four cases of abscess and gangrene of the pancreas operated upon by Körte, two recovered and two died.

Hæmorrhages of the Pancreas are usually conditioned upon diseases of the heart, the lungs, or the liver, with congestive hyperæmia of the abdominal viscera. Death sometimes occurs suddenly in consequence of hæmorrhage of the pancreas ("pancreatic apoplexy"), especially among very fat people (Zenker). In such fatal cases the hæmorrhage is sometimes strikingly slight, and Zenker has therefore suggested that death may have been caused by paralysis of the heart and pressure of the extravasation of blood upon the solar plexus and the semilunar ganglion. It would then, to be sure, be difficult to understand why death does not ensue more frequently from pressure upon the nerve plexus named. The results of investigations made by Balser, Chiari, and others have special interest in connection with our inquiry, which shows that in very fat persons large amounts of the abdominal fat sometimes undergo necrosis, especially in the neighbourhood of the pancreas. Death may ensue more or less suddenly, much as in Zenker's pancreatic apoplexy, in consequence of this fat necrosis, which occurs with or without hæmorrhage into the pancreas.

Pancreatic hæmorrhages take the form either of circumscribed hæmatomata, hæmorrhagic cysts, or more diffuse effusions of blood in and about the pancreas. Hæmorrhagic cysts may also arise from hæmorrhages into a pre-existing cyst in consequence of the rupture of vessels in its wall. Diffuse hæmorrhages are usually a result of chronic disease of the blood-vessels, parenchymatous degeneration of the gland, or acute hæmorrhagic pancreatitis, sometimes with marked enlargement of the gland. Rupture of varicosities is sometimes a cause of hæmorrhage. In diffuse hæmorrhages of the pancreas that take a fatal course, the above-mentioned fat necrosis described

by Balser and Chiari may play a part. An explanation of these pancreatic hæmorrhages, which covers all cases, is not as yet possible. Death sometimes occurs so suddenly and unexpectedly from collapse that a careful observation of the patient has not been possible. In other cases the symptoms of intestinal obstruction make their appearance in consequence of compression of the intestine by the extravasated blood or the enlarged pancreas. The diagnosis of such cases is very difficult.

There is usually no treatment, properly speaking, because the nature of the disease is not recognised, or because death takes place suddenly, so that medical aid comes too late. In suitable cases, with indications of internal hæmorrhage, the attempt should be made to arrest the same by performing laparotomy and exposing the pancreas behind the stomach.

Fatty Degeneration of the Pancreas.—Infiltration of the interstitial connective tissue with fat and fatty degeneration of the gland cells is observed especially among alcoholics and fat people. Fatty degeneration, as was said above, is sometimes combined with hæmorrhages, in consequence, probably, of rupture of the walls of vessels that have undergone fatty degeneration. If the function of the pancreas is completely suspended by fatty degeneration of the substance of the gland, increasing marasmus has sometimes—not always—been observed, especially in those cases in which the passage of the bile from the common duct, which lies adjacent to the pancreatic duct, is obstructed by shrinkage of the organ. If the secretion of the bile and the pancreatic juice is disturbed, the emulsion of fats is chiefly affected.

A surgical treatment of fatty degeneration of the pancreas is only possible when a hæmorrhage or hæmorrhagic cyst (see below, Tumours) is recognised.

Concretions of the Pancreas.—The formation of concretions in the pancreatic ducts is rare. Pancreatic stones consist chiefly of carbonate of lime and vary considerably in size. They are sometimes only as large as a millet grain or a grain of rice, and then again they attain the size of a hazelnut, or may be even larger. Stones with a diameter of from three to four centimetres have been observed. They are usually of a round or oval form, and their surface may be smooth or uneven. They are sometimes jagged and have spurs corresponding to the branches of the pancreatic duct similar to stones of the pelvis of the kidney. Pancreatic stones sometimes become impacted temporarily or permanently in the pancreatic duct. If the excretory duct is permanently closed, the gland undergoes corresponding atrophy. Retention cysts are formed only when the retained pancreatic juice is not absorbed. Suppuration also has resulted from stone formation in the pancreas.

Symptoms are frequently absent in case of stones of the pancreas, and the concretions are found by accident at the autopsy. Severe pain and disturbances of digestion may arise from impaction of the stones, as well as fatty stools. Jaundice is occasioned by pressure of larger concretions upon the common bile duct. A sure diagnosis of pancreatic lithiasis is, as a rule, impossible. Surgical treatment is only to be thought of when there are demonstrable secondary conditions—that is, in case of severe jaundice, abscesses, or cysts (see Tumours).

Tumours of the Pancreas.—Of the tumours of the pancreas, cysts are of most interest. A comparatively large number of pancreatic

cysts has already been reported. I mention, for example, the cases of Senn, Dixon, Palzer, Billroth, Gussenbauer, Riedel, E. Hahn, Thiersch, Wölfler, Bull, Karewski, A. Martin, Kocher, Gould, and others. Boeckel has collected forty-four cases from literature. The etiology of cysts is very variable. They are sometimes formed in consequence of closure of the pancreatic duct, when the absorption of the pancreatic juice is prevented by pathological changes in the secretion or the vessels. Closure of the duct is not of itself sufficient, because then, in case of normal capability of absorption on the part of the secretion and the vessels, the retained pancreatic juice is entirely absorbed. In other cases the cysts develop in connection with inflammations extending, for example, from the duodenum, also after injuries, from traumatic or spontaneously developed hæmatomata, etc. In a portion of the cases the origin is obscure. Cysts sometimes reach an enormous size. Their contents are very variable. They sometimes consist of retained pancreatic juice, are sometimes purely serous, are sometimes bloody or



FIG. 428. — Pancreatic cyst in a man forty years of age (Gussenbauer).

tinged with blood, and sometimes purulent. Hæmorrhagic cyst contents have been frequently found to contain a striking amount of granular globules (F. Küster). A portion of the supposed cysts arose from circumscribed hæmorrhages or abscesses. In the case observed by Gussenbauer of a cyst that had developed suddenly in a man of forty (see Fig. 428) the origin was obscure. Its contents consisted of altered blood. Gussenbauer made the conjecture that there might have been a melano-sarcoma of the pancreas which had been exposed to the digestive action of the pancreatic juice. The admixture of blood may in reality be the consequence of the digestive action of the pancreatic juice upon diseased gland tissue. In the hæmorrhagic cysts of the pancreas we have to do

either with a hæmatoma with subsequent cyst formation (so-called apoplectic cysts), or with hæmorrhages into an already existing cyst. Leaving out of consideration the rare abscesses and echinococcus cysts, we usually have to do with hæmorrhagic and pure retention cysts involving the gland lobules or Wirsung's duct. Diabetes mellitus resulting from total destruction of the pancreas was observed but three times among forty-four cases.

The diagnosis of pancreatic cysts is sometimes difficult ; in fact, it has been correctly made before the operation in only a minority of the cases. The location of the tumour in the region of the pancreas behind the stomach, its fluctuating character, and, as opposed to an abscess, the lack of all symptoms of local and general inflammation, are especially important for the diagnosis. The contents of the cysts are, as we said, very variable, so that the chemical and microscopic examination of the same gives no constant results. The presence of trypsin is, however, characteristic of pancreatic cysts.

One should be cautioned against making a trial puncture on account of the possibility of associated injuries, to the stomach for instance (Karewsky), and the escape of the fluid into the peritoneal cavity.

The best treatment of cysts of the pancreas is incision and drainage, which was first practised by Gussenbauer. After the abdominal wall has been opened in the median line above the umbilicus and the stomach separated from the transverse colon, the wall of the cyst is sutured to the parietal peritonæum in the wound, and then immediately—or, better, after adhesion of the cyst wall with the parietal peritonæum, about the fourth or fifth day—the cyst is opened, a trial puncture having been made beforehand. As the pancreas has a retroperitoneal location, it is necessary to divide the peritonæum bluntly in front of the cyst, unless it has already been broken through by the latter, and to detach it sufficiently. After incision of the cyst, a drainage-tube of proper size should be introduced and the sac allowed to heal gradually by shrinkage. The method of operating in two stages with suture of the wall of the cyst to the parietal peritonæum is easiest in cases of large and thick-walled cysts. In smaller ones, on the other hand, the tension is sometimes too great, so that the insertion of sutures may be impossible. Large, tense cysts should be simply allowed to heal into the abdominal wound by packing the same without suturing the cyst wall, and the incision made some days later. The method of operating in two stages is always the more reliable, and the results secured by it are favourable. The last nineteen operated cases that were reported all terminated favourably (Boeckel). In some cases it is preferable to close the anterior incision and employ lumbar drainage. The duration of the healing process is shortened in this way, which has varied in the cases thus far reported from one to nine months. In suitable cases the complete extirpation of the cyst may be undertaken, which leads to a more rapid cure but is more dangerous.

Of other tumours, the carcinoma occurs most frequently and is either a primary growth or secondary to cancerous disease of the neighbouring organs. Primary carcinoma of the pancreas takes the form usually of hard

nodules, less often soft ones. Mirailié has collected one hundred and fifty cases of primary carcinoma. It is most frequently observed among alcoholic individuals above forty or forty-five years of age. Primary carcinoma is located most commonly in the head of the pancreas and spreads from here to the duodenum and the neighbouring lymph glands, less often to the stomach, the common bile duct, the liver, the spinal column, and the vena cava. Involvement of the duodenum may give rise to stricture and even complete obstruction of the same.

The symptoms of carcinoma of the pancreas are epigastric pain and disturbances of digestion with fatty stools, vomiting, and increasing emaciation. Large nodules can be felt behind the stomach by deep palpation. The tumour is often lifted rhythmically by the pulsation of the aorta. Jaundice may arise from pressure of the carcinoma upon the common bile duct. Stenosis of the duodenum may be caused by compression or secondary involvement of the same, with symptoms, it may be, of intestinal obstruction.

Diabetes is, according to Mirailié, Courmont, and others, always present in the first stages of primary carcinoma of the pancreas, but disappears in the later stages and before death. The following explanation has been given for this: Carcinoma and sclerosis of the pancreas destroy at the outset the antidiabetic function of the gland; the growing tumour, on the other hand, obstructs in time the common bile duct, causing icterus and complete disorganization of the liver tissue, which in time prevents the formation of sugar by the liver. The diabetes accordingly disappears, and the cachexia becomes fatal. The diagnosis of a carcinoma of the pancreas is usually very difficult and uncertain.

A successful treatment of carcinoma of the pancreas is ordinarily impossible, as the diagnosis is usually not made early enough. If the tumour can be felt, it is too late for a successful extirpation. Carcinomata of the tail of the pancreas are most favourable for extirpation, because the pancreatic duct can then be preserved. In all partial resections of the pancreas one should tie off the remainder of the gland by ligatures *en masse* and preserve the head and the duct as far as possible. Complete extirpation of the pancreas may have a fatal course, especially from gangrene of the duodenum. In inoperable carcinomata of the pancreas life could perhaps be prolonged in some cases by gastro-enterostomy (see § 169).

Sarcomata of the pancreas are very rare. Senn mentions three cases of primary sarcoma (Mayo, Lépine-Cornil, Paulick). Secondary sarcoma of the pancreas arises from the extension of a sarcoma of the neighbouring organs, seldom from metastasis.

Intestinal obstruction may arise from pressure of a tumour of the pancreas upon the intestine. Hagenbach collected twelve cases of enlargement of the pancreas with compression of the intestine. Laparotomy was performed three times, with a fatal termination in each case. The location of the supposed stenosis of the intestine was not found at the operation. The tumour was in most cases a carcinoma. In case of closure of the common bile duct by tumours of the pancreas, cholecystenterostomy (see page 63) is indicated.

§ 164. **Surgery of the Spleen.**—For the surgery of the spleen, with special reference to its extirpation, its function is of particular interest. The following brief account of its physiology may therefore be allowable by way of introduction :

Function of the Spleen ; Consequences of its Extirpation.—Opinions differ greatly as to the function of the spleen. We know, to begin with, that in man the spleen can be extirpated without injury, and that it is absent, in rare cases, in otherwise perfectly healthy persons. A hypertrophy of all the lymphatic glands usually follows extirpation of the spleen, sometimes also hypertrophy of the thyroid gland, and the blood-forming activity of the bone marrow is increased. After a successfully performed extirpation of the spleen there is noticeable at first a striking anæmia and emaciation of the patient ; the number of white blood-corpuscles is increased and that of the red diminished. The amount of hæmoglobin is correspondingly lessened, and many nucleated red corpuscles are found. The patient recovers very gradually but completely, and after a time the blood usually becomes normal. In frogs, which have no lymphatic glands, brownish-red nodules were seen to develop on the intestine after extirpation of the spleen, and these were interpreted as substitute organs for the spleen.

It is assumed by most authors that the spleen is a blood-forming organ ; old, used-up red blood-corpuscles are destroyed in it and new ones formed (Gerlach, Funke, Kölliker, Ecker). Other authors have taken very decided ground in opposition to this view. According to Bizzozero, Foa, Salvioli, and others, the spleen has the capacity to exercise a blood-forming activity only under certain circumstances—e. g., in case of acute anæmia resulting from a severe loss of blood. The comparison of the blood in the splenic vein with that in the splenic artery has thrown but little light upon the function of the spleen. It is certain, however, that large numbers of white blood-corpuscles are formed in the spleen in leukæmia.

By virtue of its unstriped muscular fibres, the spleen has the ability to change its size. After stimulation of the spleen and its nerves by electricity, cold, or certain medicines (ergot, quinine), it grows smaller and the liver then usually enlarges. The spleen has also been regarded as a regulating apparatus for the blood supply of the digestive organs. It changes its volume repeatedly during the day. After digestion, when the digestive organs contain but little blood, the spleen enlarges. A striking greediness has been observed on the part of animals after extirpation of the spleen. That the digestive power of the pancreas is lessened and that of the stomach increased after extirpation of the spleen, as Schiff supposes to be the case, has not been proved.

The nerves of the spleen are chiefly vasomotors. Their centre lies therefore in the medulla. They run from here through the spinal cord, and through the left splanchnic nerve and the semilunar ganglion into the splenic plexus (Jaschkowitz). As stimulation of the medulla and nerves of the spleen causes a diminution in the size of the organ, so paralysis causes its enlargement. Enlargement of the spleen also occurs from prolonged anæsthesia (Bulgar).

Malformations of the spleen are very rare. Congenital absence of the organ has been observed in exceptional cases in otherwise perfectly healthy

persons. Abnormities in the external form of the spleen are more common. Instead of having a tongue-shaped form, the spleen is sometimes strikingly lobulated and has deep notches. An accessory spleen is not infrequently present, or there may be several such of about the size of a bean or a hazelnut. Changes of position occur in the spleen just as in the kidney (see page 77, Movable Spleen).

Spontaneous, non-traumatic ruptures of the spleen occur in countries where there are severe forms of malaria and in connection with other infectious diseases. Whether in such cases recovery would be possible by performing laparotomy is doubtful, to say the least.

For injuries of the spleen, see §§ 155 and 156.

Inflammations of the Spleen are very frequent. Micro-organisms are easily deposited from the blood current in the spleen, because the circulation is slow in its large capillaries and veins, and the walls of its vessels are very pervious. The inflammation and swelling of the spleen in all acute infectious diseases are therefore easily understood. Suppurative inflammation of the spleen, or splenic abscess, is of chief interest to the surgeon.

Abscess of the spleen occurs usually after injuries, in the course of acute infectious diseases—typhoid fever, for example; also in connection with pyæmia, etc. The etiology of splenic abscess is sometimes not perfectly clear. Chronic suppuration is most frequently caused by actinomycosis and tuberculosis. The suppuration is either more or less diffuse, or circumscribed, in the form of one or several abscesses of different size. Corresponding destruction of the tissue of the spleen is naturally combined with the suppuration. Suppuration of the entire spleen, sometimes ensues, and it is transformed into a purulent or grayish-red, pulplike mass. Abscesses of the spleen may break through the capsule in the most varied directions—e. g., into the peritoneal cavity, the stomach, the large intestine, the splenic vein, or through the diaphragm into the thoracic cavity, or externally, which is the most favourable course, through the thoracic or abdominal wall. In case the pus ruptures into the peritoneal cavity, either death from general suppurative peritonitis follows, or a circumscribed abscess is formed in the peritoneal sac after the suppuration has become encapsulated by adhesive peritonitis. Rupture of an encapsulated perisplenic abscess may cause extension of the pus into the retroperitoneal tissue—e. g., behind the large intestine, and from here into the perirectal connective tissue, with rupture into the vagina.

The diagnosis of an abscess of the spleen is based mainly upon pain and inflammatory symptoms in the region of the lower ribs near the stomach, upon enlargement of the organ, and upon an exact history

of the patient as regards any previous illnesses. Œdema and swelling of the skin in the neighbourhood of the spleen are observed particularly in connection with perisplenic abscesses.

The treatment of splenic abscess follows general surgical principles. The presence of pus should first be determined by trial puncture with an aspirating syringe, and then, as Lauenstein recommends, the abscess is exposed with the aspirating needle as a guide, and, in case it is already encapsulated, incised and drained at once. If the abscess is not yet adherent to the abdominal or thoracic wall, the same course should be pursued as in treating abscesses of the liver—that is, the wall of the abscess is made to unite with the abdominal wound, with or without suture, and then an incision made four or five days later. One may in some cases suture the wall of the abscess to the parietal peritonæum, and open the abscess immediately by incision or puncture. If necessary, the field of operation may be made more accessible by resection of a rib. Even in case of beginning general peritonitis an effort should still be made to save the patient by laparotomy (see above, page 39, Treatment of Peritonitis).

Tuberculosis and syphilis of the spleen are little suited for surgical treatment. Tubercles are frequently found in the tissue and in the capsule of the spleen, especially in connection with general miliary tuberculosis, and sometimes large tubercular nodules.

An enlargement of the spleen frequently occurs in the course of syphilis, especially during the invasion stage and in its later periods. Syphilitic enlargement of the spleen is conditioned partly on a proliferation of the pulp cells and partly upon hypertrophy of the connective tissue. Gummata are not common.

Leprosy and actinomycosis are also occasionally located in the spleen. Actinomycosis in particular gives rise to characteristic suppurative inflammations of the spleen, and one should therefore always think of the possibility of the presence of actinomyces in connection with abscess of the spleen (see also with reference to leprosy and actinomycosis, Principles of Surgery, §§ 85, 86).

Aneurisms of the splenic artery are rare. Selter described a case which had resulted from an increase in the blood pressure due to an embolus. The treatment should be splenectomy and extirpation of the aneurism.

Movable Spleen.—We have already briefly mentioned congenital changes of position of the spleen. The acquired movable spleen which occurs especially among women after pregnancy, and also after a fall, or as the result of enlargements of the organ (hyperplasia from malaria or leukæmia or tumours), is more common. The changes of position of the spleen arise mainly from the gradual stretching of its accessory ligaments—the phrenico-splenic and the gastro-splenic—by means of

which the spleen is attached to the diaphragm and the stomach. Hyrtl questions whether movable spleen can arise suddenly from rupture of these ligaments in consequence of a fall; but they may, at all events, be stretched from this cause, so that movable spleen can really have a traumatic origin. In severe cases of movable spleen the organ may sink as far as the region of the left or even that of the right crest of the ilium. The hilum of the spleen is usually directed downward. In consequence of this changed position of the organ, corresponding pain and circulatory disturbances exist, as well as disturbances of digestion in consequence of traction on the stomach. Death has been observed also from gangrene of the wall of the stomach and closure of the duodenum by the pancreas, which is likewise drawn downward in connection with movable spleen. A striking atrophy of the spleen sometimes occurs in consequence of the disturbance in its circulation. Twisting of the pedicle may, by compression of the vessels, have more or less serious consequences (infarct, rupture, softening, gangrene).

As regards the diagnosis of movable spleen, it is characteristic that the splenic dulness is absent at the normal place, and that there is a movable tumour resembling the spleen at a lower part of the abdomen.

The discomfort attending movable spleen is sometimes so slight that special treatment is unnecessary. The wearing of an abdominal binder is sufficient in mild cases, and prevents the trouble from becoming any worse. If much suffering is occasioned, or if serious symptoms develop in consequence of traction on the stomach and compression of the duodenum, extirpation of the spleen may be indicated (B. Crédé). Lieffring has collected forty-two cases of extirpation of a movable spleen, of which only two terminated fatally. For the technique of splenectomy the reader is referred to pages 81 and 82. Attempts at securing a movable spleen in its normal position with sutures (splenopexy) have been in most cases unsuccessful, and the same is true of ligation of the splenic artery with the idea of bringing about contraction of the enlarged spleen. Rydygier recently performed splenopexy with success in the following way: After opening the abdominal cavity a transverse incision with its convexity upward is made through the parietal peritonæum in the vicinity of the eleventh, tenth, or ninth rib; the peritonæum is dissected up bluntly so as to form a pocket open above, and the spleen is placed within this and secured by sutures passed through the gastro-splenic ligament and the spleen itself. In order to prevent the spleen from enlarging the pocket, the peritonæum at the bottom of the same is sutured to the subjacent tissue.

Tumours of the Spleen.—We have mentioned above the acute and chronic hypertrophy of the spleen which attend acute and chronic infectious diseases. Chronic hypertrophies, or tumours of the spleen, include amyloid degeneration of the spleen, and particularly the enlargements which occur in the course of leukæmia and pseudo-leukæmia (splenic and lymphatic anæmia, Hodgkin's disease). While true leukæmia is characterized by a very striking increase in the number of the white blood-corpuscles, this increase does not take place in pseudo-leukæmia. The causes of the leukæmic and pseudo-leukæmic tumours of the spleen which occur at every age are as yet wholly obscure. The size of the tumour of the spleen attending these diseases may be very marked, so that the spleen extends beyond the median line of the abdomen. In connection with these leukæmic and pseudo-leukæmic tumours of the spleen there are usually similar hypertrophies of the lymph glands and cellular proliferations within the bone marrow. The splenic tumour usually develops first, and then the hypertrophy of the lymph glands. Sometimes, however, especially in leukæmia, this order is reversed. Both diseases—leukæmia and pseudo-leukæmia—pass into one another, and the possibility that they are identical has been suggested (see also *Principles of Surgery*, p. 763, *Malignant Lymphoma*). The chronic hypertrophy of the spleen attending leukæmia and pseudo-leukæmia usually takes the form of an increase of all the component parts of the organ. In the later stages, however, the enlarged spleen loses its normal structure, and is composed more and more of a cellular, fibrous tissue. The extirpation of the simple, and particularly of the leukæmic tumours of the spleen, should not be attempted, on account of the great danger attending the operation (see page 81). Mosler recommends parenchymatous injections into the spleen (carbolic acid, Fowler's solution of arsenic, etc.; see page 82).

Primary neoplasms of the spleen are very rare. Metastatic tumours in connection with carcinoma and sarcoma, and especially with lymphosarcoma, are more common. Of primary tumours, fibromata, angeliomata, sarcomata, and dermoid cysts have been observed. The most frequent cysts of the spleen are those caused by the echinococcus. Trinkler, who collected seventy cases of echinococcus of the spleen in patients from eleven to seventy-two years of age, estimates its frequency at 3·2 per cent of all cases of echinococcus. Aside from the latter there occur, of animal parasites, particularly the pentastomum and the cysticercus.

In case of a tumour or enlargement of the spleen, a careful examination of the patient should be made while under an anæsthetic, and the size of the tumour determined by percussion and palpation in the

vicinity of the free border of the ribs on the left side. Tumours of the spleen are often very movable.

The treatment of splenic tumours is, of course, operative in its character as soon as they cause disturbances or, from their malignancy, threaten the life of the patient. In case of echinococcus of the spleen, one should adopt the same method as that described in detail (page 56) for treating echinococcus of the liver.

Puncture should be avoided on account of its dangers. Whether one should perform incision in one or two stages, or extirpation of the echinococcus cyst or the spleen, depends upon the condition found on opening the abdomen.

Extirpation is especially indicated in case of malignant tumours, and its results are very favourable. We have already stated (page 75) that the removal of the spleen produces no evil effects in man. Péan was, no doubt, the first to perform a successful splenectomy on an organ that had undergone cystic degeneration. He had made a diagnosis of an ovarian cyst, and did not discover until during the operation that he had to do with a cyst of the spleen. After injuries also, the spleen, which has been crushed or which has become prolapsed and can not be replaced, has been extirpated with good results. Barrault collected eleven cases of extirpation of the spleen in which the organ had become prolapsed in consequence of injuries. All these patients recovered. B. Crédé, after a successful splenectomy, collected thirty-seven cases from literature, twenty-seven of which terminated fatally. This high mortality of seventy-eight per cent has been now reduced by the introduction of aseptic methods of operating. There were also included in this number several cases in which the extirpation was performed for leukæmic enlargement of the spleen. Asch tabulated ninety cases, thirty-nine of which, or 43·3 per cent, terminated fatally. Among these were forty-three cases of hypertrophy of the spleen, and of these patients thirty-eight died (mortality of eighty-eight per cent). The prognosis of splenectomy for leukæmic tumours is most unfavourable (mortality of ninety-five per cent), while the mortality attending operations for simple hypertrophy of the spleen or that conditioned upon malaria is but little less, amounting to 80·9 per cent. Wright and others reached similar results. Death was due in these cases to uncontrollable hæmorrhage at the time of the operation, or to secondary hæmorrhage. II. Burckhardt twice removed a leukæmic tumour of the spleen with success, but death followed three and eight months after the operation, because, in spite of removal of the splenic tumour, the leukæmia continued to progress. The extirpation of splenic tumours is easiest, of course, when they are

still movable. Firm and extensive adhesions, especially those with the diaphragm, make the operation much more difficult, or render its completion impossible. Regarding the consequences of extirpation of the spleen, the reader is referred to page 75.

Operations on the Spleen.—The operations which are undertaken upon the spleen are mainly incision (splenotomy) and extirpation (splenectomy).

Incision of the spleen (splenotomy) is performed usually for abscess and echinococcus, and in dealing with both the same general method is used that we have described in detail for the liver (page 51).

Extirpation of the spleen (splenectomy), which was first successfully performed by Péan for cystic degeneration of the organ, is especially indicated in case of injuries of the spleen—e. g., serious contusions with gangrene, wounds with severe intra-abdominal hæmorrhage, prolapse of the organ through the abdominal wall, in marked cases of movable spleen, and, finally, for malignant splenic tumours. We mentioned above that extirpation of leukæmic tumours of the spleen should, generally speaking, not be attempted.

The technique of splenectomy is as follows: The operation, like every laparotomy, should be performed under the strictest observance of the usual aseptic and other precautions (see Laparotomy, page 45). The incision through the skin may be made either in the linea alba, encircling the umbilicus on the left side, or along the outer border of the left rectus muscle, or, finally, in the region of the spleen, according to the nature of the case, the size of the tumour, etc. Czerny and Kocher and the majority of surgeons prefer the incision in the linea alba, because one can in this way more easily reach the hilum of the spleen. One may add to the longitudinal incision, at the level of the umbilicus, a transverse one running to the left. After the spleen has been exposed by a sufficiently long incision, the intestines are held to one side by means of large aseptic gauze compresses. The two accessory ligaments of the spleen—the gastro-splenic and the phrenico-splenic—and the vessels that run in them are then tied in two places with catgut or silk and divided between the ligatures. Any adhesions of the spleen are treated in a similar manner. Adhesions with the omentum can also be divided later extra-abdominally, after bringing the spleen out through the abdominal wound. In place of distal ligatures one may use artery clamps for the splenic end of the adhesions. Superficial adhesions and parenchymatous bleeding may be treated by means of the thermo-cautery. If there are firm and extensive adhesions with the diaphragm, extirpation will, in the majority of cases, have to be given up. Care must always be taken in the course of the operation that the capsule of the spleen is not injured, thus causing parenchyma-

tous bleeding. The most difficult part of the operation consists in finding the hilum and dividing it without hæmorrhage. The hilum is either tied *en masse* by means of two ligatures of catgut or silk and then divided between these, or the artery and vein are each ligated separately. The surest way is to apply at first a ligature *en masse*, and then in addition to tie separately the artery and vein in the stump of the pedicle. The pedicle is divided with the knife or thermo-cautery, and then dropped back or sutured into the wound, as was done by Péan, for example, as a precaution in case of secondary hæmorrhage. Billroth was obliged to sever with the cautery a portion of the pancreas that was adherent to the spleen. The abdominal wound, after the peritoneal cavity has been cleansed, if necessary, with large aseptic sponges or gauze pads, is finally closed by suture.

The extirpation of a movable spleen is performed upon essentially the same principles. The removal of a spleen that has prolapsed through the abdominal wound, whether injured or uninjured, may be very simple. It consists chiefly in double ligation of the pedicle and division of the same between the ligatures. If the spleen which is not too severely injured or is intact can be replaced, this may be done in fresh cases, after disinfection of the organ, especially in the case of partial prolapse. Should it be desirable in the latter case to remove only a part of the spleen—e. g., on account of its being crushed—this may be accomplished by applying an elastic ligature behind a spear-pointed needle that is stuck through, and letting the organ lie in the wound, or by gradually destroying the prolapsed and contused part with the cautery. According to a tabulation by Ledderhose, the organ was replaced four times (one recovery), resection was performed ten times (ten recoveries), and extirpation eighteen times (eighteen recoveries).

Partial resection of the spleen has been repeatedly performed with success—e. g., for new growths or cysts (Gussenbauer, Bardenheuer). After removal of the diseased portion by means of the cautery, for example, any hæmorrhage that still occurs is arrested by a deep suture.

Ligation of the splenic vessels, as recommended by Clement Lucas, (1882), for bringing about shrinkage of the organ in cases of hypertrophy of the spleen, is not advisable. The two cases that were published terminated fatally.

Parenchymatous injections into the spleen—e. g., in case of chronic enlargement of the organ—are made with very fine aspirating needles under antiseptic precautions. In order that none of the fluid may escape into the peritoneal cavity when the needle is withdrawn, the piston of the syringe should be drawn back so as to aspirate any fluid that may remain in the needle.

CHAPTER XIX.

SURGERY OF THE STOMACH AND THE INTESTINAL CANAL (WITH THE EXCEPTION OF THE RECTUM AND THE ANUS).

Surgery of the Stomach: For injuries, see §§ 155, 156.—Malformations.—Surgical treatment of diseases of the stomach.—Operations on the stomach.—Lavage.—Gavage.—Gastrotomy; gastrorrhaphy; gastrostomy.—Closure of acquired gastric fistulae.—Pylorotomy.—Gastro-enterostomy.—Duodenostomy.—Operative treatment of adhesions and displacements of the stomach.—Hour-glass stomach and dilatation.—Foreign bodies in the stomach and intestinal canal.

Surgery of the Intestinal Canal: For injuries, see §§ 155, 156.—Malformations.—Inflammatory processes.—Perforation of the intestines.—Tumours.—The various kinds of intestinal obstruction (internal strangulation from intussusception, volvulus, etc.).—Indications for and technique of operations on the intestine (the rectum excepted).—Enterotomy and enterorrhaphy.—Enterostomy (formation of an artificial anus).—Resection of the intestine.—Operative treatment of artificial anus and fæcal fistula.

§ 165. **Surgery of the Stomach.**—Of congenital malformations of the stomach, prolapse of the mucous membrane through the umbilicus was mentioned above (page 12). Of other malformations of the stomach, which have, however, but little surgical importance, I mention particularly the following: In very rare cases congenital atresia of the pylorus has been observed. Congenital abnormalities in the position and shape of the stomach are more common—e. g., in connection with situs transversus, congenital defects of the diaphragm or congenital abdominal fissure. The foetal vertical position occasionally continues after birth. The stomach has in rare cases—e. g., in consequence of congenital or acquired constrictions—the form of an hour-glass. Finally, the septa which sometimes occur in the stomach may be mentioned.

Regarding injuries of the stomach, the reader is referred to §§ 155 and 156.

Of other diseases of the stomach which may require surgical treatment, we mention particularly the entrance of poisons and foreign bodies into the same, hæmorrhages attending gastric ulcer, perforation of the stomach in consequence of ulceration and injury, stenoses at the cardiac and at the pyloric orifices, especially cicatricial stenoses, and finally tumours, particularly at the pylorus. Tuberculosis of the stom-

ach is very rare. It sometimes leads to the formation of ulcers which develop from the lymph follicles of the stomach, as in the intestine (O. Barbacci). The deep location of the lymph follicles, the composition of the gastric juice, the comparatively short stay here of the ingesta, which are in constant motion, etc., all serve to explain why primary tuberculosis of the stomach is very rare.

It may be well to describe here in detail the different operations that have been recommended for the above pathological conditions, and in doing this to take up briefly the essential characteristics of the different diseases from a surgical standpoint. For the symptomatology, diagnosis, and medical treatment of the diseases proper of the stomach the reader must be referred to treatises upon internal medicine.

Different attempts have been made to render the interior of the stomach visible, but the gastroscopes that have thus far been employed are of little practical use. The gastroduaphanoscope invented by Einhorn, Kuttner, and Jacobson consists of a rubber stomach tube with a small electric lamp and a supply tube for air or water. The patient is given one half to one and a half litres of cold water to drink before the introduction of the stomach tube. The outlines of the stomach, transverse colon, and the left lobe of the liver can then be seen through the abdominal wall, any thickenings are recognised, etc. The best time for an examination is from four to five hours after the principal meal. Kuttner and Jackson tried illumination in three hundred cases. A dark room is not necessary. A standing posture is preferable. Dangers in the way of burns, etc., need not be considered, and it is contra-indicated only in case of ulcer of the stomach, aneurisms, etc.

Lavage of the Stomach is performed usually for acute and chronic gastritis, dilatation of the stomach, poisoning, intestinal obstruction, and as a preliminary to operations on the stomach, in order to empty the latter as completely as possible. As irrigating fluids use is made of lukewarm water, a warm, three-quarters-of-one-per-cent solution of common salt, or, for the sake of simultaneous disinfection, a non-poisonous antiseptic—e. g., a from two- to three-per-cent solution of boric acid or a one-third-of-one-per-cent solution of salicylic acid. In case of poisoning, solutions should be used which are capable of neutralizing the poison in question (see § 166, pages 100–103, *Foreign Bodies in the Stomach*).

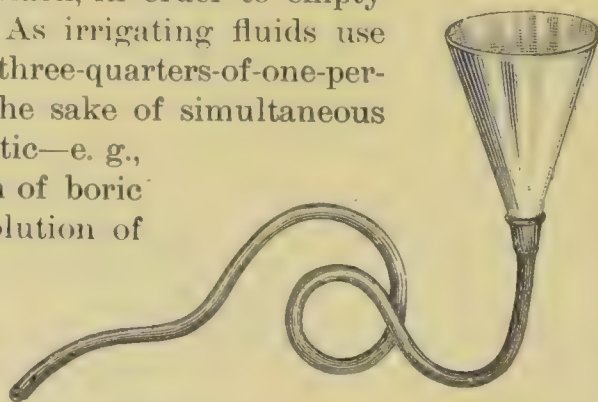


FIG. 429.—Stomach tube with glass funnel.

Lavage is performed by introducing into the stomach through the pharynx and the œsophagus an India-rubber tube of the thickness of the finger, which is besmeared with vaseline or oil. A glass funnel is now attached to the upper end of the tube (Fig. 429), the irrigating fluid is poured into the stomach, and the contents of the latter removed by siphon action, the funnel

being lowered as far as possible. This process of filling and emptying the stomach by raising and lowering the funnel is repeated as necessity may require until the stomach is thoroughly cleansed. The removal of the contents of the stomach may also be accomplished by the use of aspiration syringes—so-called stomach pumps—but this method is not so good. In washing out the stomach, one should not pour in the water in too large amounts or under too great pressure, as injuries to the mucous membrane of the stomach may easily occur, or even complete rupture of the organ, especially when the latter is diseased. Algot Key-Aberg produced on the cadaver, by the injection of from three to four litres of water, from a height of two feet, laceration of the mucous membrane of the stomach and complete rupture of its walls, especially at the small curvature near the cardiac end, where the pressure of the contents of the stomach reaches its maximum.

In feeding patients through the stomach tube—e. g., after operations in the mouth and the larynx—the fluid food should likewise be poured slowly into the funnel.

Gastrotomy and Gastrorrhaphy.—Gastrotomy is most frequently performed for the removal of a foreign body from the stomach, and it is especially indicated when the body is pointed, sharp, or angular, whose passage through the intestine and exit *per rectum* is improbable or attended with danger to life. Gastrotomy is also performed in all those cases in which great pain is caused by the foreign body or abscess formation and perforation of the stomach are threatened. The greatest variety of foreign bodies, including some that seem incredible, have been observed in the stomach, as described especially by Nussbaum in *Die Deutsche Chirurgie*, Lieferung 44. For a more detailed description of the symptoms and the course of foreign bodies in the stomach the reader is referred to § 166, page 100, where, for the sake of convenience, foreign bodies in the stomach and in the intestinal canal are spoken of together.

Gastrotomy is also indicated in case of profuse gastric hæmorrhage—e. g., in connection with ulcer of the stomach. After the stomach has been opened and the blood clots cleared away, the hæmorrhage is arrested by tying the bleeding vessel, by cauterization (Mikulicz) or by excision of the ulcer, followed in the latter case by suture of the defect (Rydygier, the author).

Küster cured permanently a gastric ulcer in the vicinity of the pylorus in two instances by cauterization of the same and gastro-enterostomy (see page 96).

Finally, cicatricial stenoses at the pylorus have been divided longitudinally, and the stricture overcome by suturing the wound in a transverse direction (Heineke). The results have been very good.

The technique of gastrotomy and subsequent suture of the wound in the stomach, gastrorrhaphy, is as follows: The preparation of the

patient consists in giving him a lukewarm bath, washing out the stomach, and emptying the intestines by means of enemata, etc. Just before the operation, opium is given either by mouth or by enema. The operation itself, which is performed with the strictest observance of antiseptic precautions, consists of three parts: 1. Opening the peritoneal cavity. 2. Finding and opening the stomach. 3. Suture of the wound in the stomach (gastrorrhaphy) and the abdominal incision.

As regards opening the peritoneal cavity (laparotomy), the reader is referred to page 45. The place where the incision is made depends upon the nature of the case—e. g., the position of a foreign body that can be felt, or of a cicatricial stenosis at the pylorus, etc. It may be made, for instance, from the ensiform process downward in the linea alba, or, as in gastrostomy, just below the ensiform process parallel to the free border of the ribs, about a finger's breadth distant from it. In case of cicatricial stenosis at the pylorus the peritoneal cavity may be opened at the outer border of the right rectus muscle or by an oblique incision, as in pylorotomy (see Fig. 435, page 93).

After the peritoneal cavity has been opened, the stomach is reached by drawing the great omentum somewhat downward; its anterior wall is pulled out through the abdominal wound and then opened with the knife. Special care must be taken not to mistake the transverse colon for the stomach. The lower border of the stomach is easily recognised, however, by the characteristic ramifications of the gastro-epiploic arteries.

After the indications have been fulfilled—e. g., the foreign body extracted, a cicatricial stenosis overcome, a dangerous hæmorrhage of the stomach arrested, or an ulcer excised—the wound in the stomach is closed by Lembert sutures of fine silk, the stomach is dropped back into the peritoneal cavity, after careful disinfection, and the abdominal wound is closed. During the incision and suture of the stomach it should rest upon large, warm aseptic compresses, so that the peritoneal cavity may be shut off by them and the wall of the stomach may rest upon an aseptic substratum. The Lembert sutures include only the serous and muscular coats, and the former should be brought into as broad contact as possible (see Enterorrhaphy, page 121). One may first apply a continuous suture of catgut or silk through the muscular and serous coats, and then over this interrupted sutures of very fine silk which are close together, or a second continuous suture.

Gastrostomy, or the formation of a permanent opening in the stomach, is indicated in case of deep, impassable strictures of the œsophagus, in order to make it possible to feed the patient through this artificial opening. Deep strictures of the œsophagus and those of the

cardiac orifice have been successfully overcome later by the introduction of bougies through such a fistula (see § 111, vol. ii, pp. 646–649).

The peritoneal cavity is opened preferably by means of an oblique incision about six centimetres long, below the xiphoid process, parallel to the free border of the left ribs and about a finger's breadth distant from it (see Fig. 435, 1, p. 93). After the peritoneal cavity has been opened and the stomach found as in gastrotomy, its anterior wall is seized with the fingers, drawn out into the abdominal wound, and there secured by a circular row of silk sutures, which include only the serous and muscular coats. The abdominal wound is bordered beforehand with peritonæum by uniting the latter with the skin by means of a continuous suture with catgut. Fixation of the stomach in the abdominal wound by means of a long acupuncture needle stuck transversely through the muscular coat during or after the insertion of the sutures is, judging from my experience, unnecessary. Only in urgent cases should the stomach be opened immediately after its attachment to the abdominal wall. If this be done, the edges of the mucous membrane may then be sutured to the outer skin. In all cases, however, in which it is possible the stomach should not be opened until its wall has become adherent to the parietal peritonæum, three or four days later, and during this time the patient is fed by means of nutrient enemata. Braun's method of suture is very good: After the wall of the stomach has been secured by superficial sutures the serous and muscular coats are incised down to the submucous layer, in order to be certain to include only the serous and muscular coats in the second row of sutures. The mucous membrane is not incised until after the insertion of this second row of sutures. The opening in the stomach should be made about large enough for the introduction of a medium-sized soft-rubber catheter. The catheter is left in for the first three or four days, and after its removal the fistula is self-closing and there is no necessity of special apparatus for this purpose. The catheter is subsequently introduced only for the purpose of feeding the patient. At one time it was the custom to make a large opening in the stomach, and some surgeons operate in this way at the present time. The larger the opening the easier it is for food to regurgitate and the more difficult is the closure of such fistulæ. Various methods were hence adopted for inclosing a large tube hermetically in the hole in the stomach (see also page 89), and for this purpose insertion pieces were attached to the India-rubber tube. Hacker recommends that the contraction of the rectus muscle be utilized for this purpose, and that the abdominal incision be made accordingly in the middle of the left rectus muscle parallel to the linea alba. Langenbeck surrounded the

tube with an India-rubber jacket which can be inflated so that it has the shape of an hour-glass. Sonnenburg recommends the introduction of a silver tube about eight days after the operation, which is closed with a cork. All these measures for closing the opening in the stomach are, however, unnecessary if a small fistula is made. The patient may be allowed later, according to the suggestion of Trendelenburg, to chew his food, and then let it pass into the stomach through an India-rubber tube (Fig. 430). In every gastrostomy the size of the pyloric and cardiac orifices should be ascertained, and in case of strictures of the cardiac opening or the lower end of the œsophagus, an attempt made to dilate them with bougies.

Gastrostomy after Hahn and Witzel.—Hahn's method is as follows: An incision five to six centimetres long is made parallel to and at a distance of about one centimetre from the free border of the ribs on the left side. The peritoneal cavity is then opened and the eighth intercostal space located (the eighth costal cartilage is joined to the seventh, which ends at the xiphoid process). Close to the junction between the eighth and ninth costal cartilages a second incision is made, and the stomach is drawn

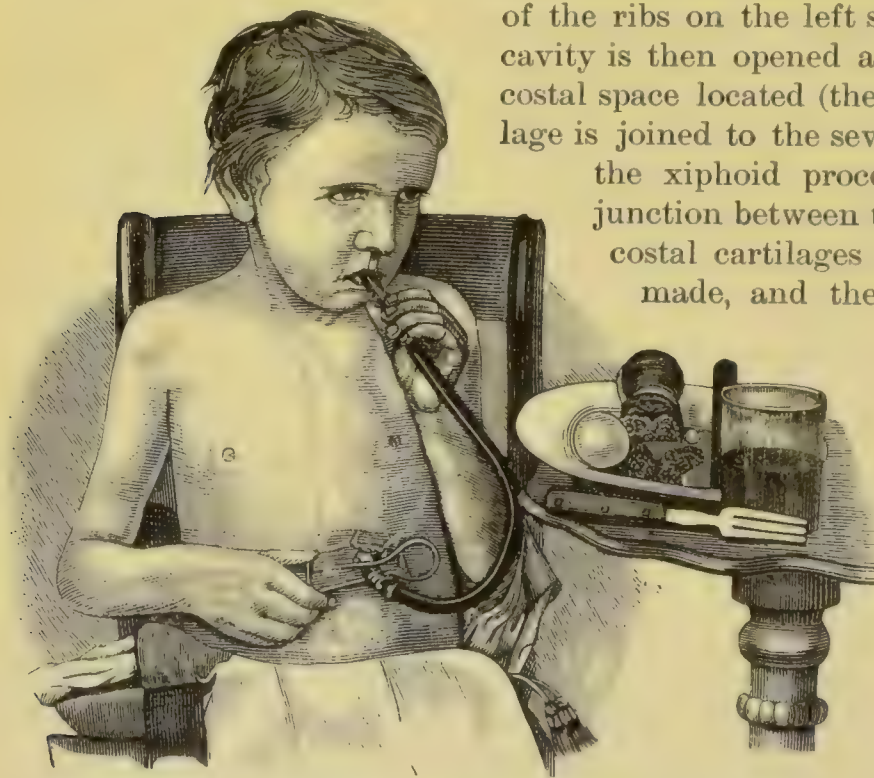


FIG. 430.—Patient feeding himself through a gastric fistula (Trendelenburg).

out here and sutured in the eighth intercostal space, etc. The first abdominal wound is then closed. Hahn mentions, as advantages of the method, the sure fixation of the stomach and good closure of the fistula without an obturator.

Witzel's method, which I used in one case with good results, is as follows: An incision is made through the skin parallel to the free border of the ribs, and a longitudinal incision in the middle of the rectus muscle and then transversely through the transversalis, whereby the action of a cross-clamp, as it were, is secured upon the India-rubber tube that is to be inserted into the stomach. The stomach is drawn into the wound, two longitudinal folds are formed in its wall, and a canal is made by suturing these folds over the India-rubber tube after the latter has been introduced into the stomach at the end of the canal (Figs. 431, 432). The stomach is secured in the wound by a circular row of sutures. Albert, Frank, and Kocher draw the stomach out

beneath a bridge of skin, in order to obtain a long, crooked course for the fistulous canal, which allows a spontaneous closure of the same. The stomach is drawn out through the abdominal wound, sutured on all sides to the peritonæum and the deep fascia, and the fibres of the rectus muscle are bluntly

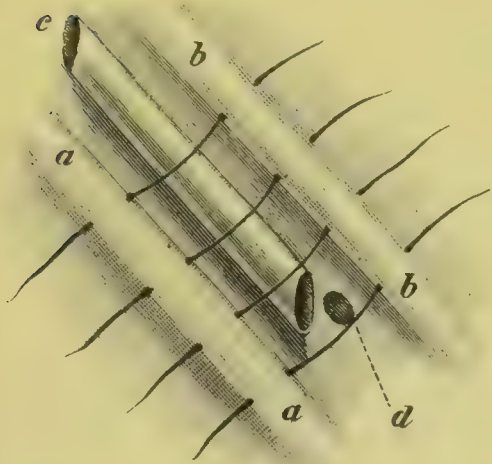


FIG. 431.—Witzel's method of gastrostomy: Formation of two longitudinal folds (*a a*, *b b*) in the anterior wall of the stomach which has been drawn out through the wound; *c*, drainage-tube; *d*, opening in the stomach.

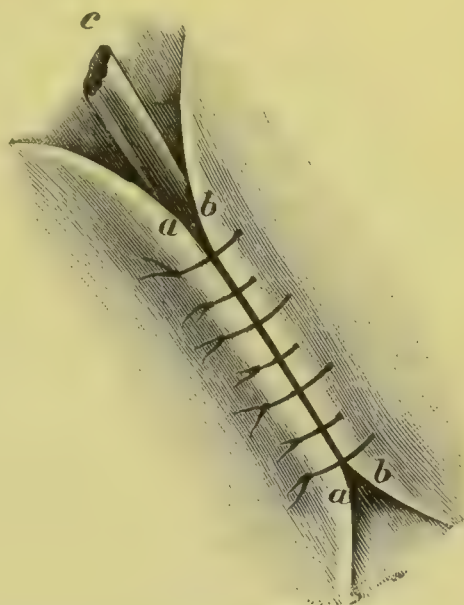


FIG. 432.—Formation of the canal by union of the two longitudinal folds *a a*, *b b*; the drainage-tube, *c*, lies in the opening in the stomach, *d*.

separated and drawn apart. An incision is then made on a level with the lower costal cartilage, the diverticulum of the stomach drawn up beneath the skin into the small incision, and here sutured (Figs. 433, 434).

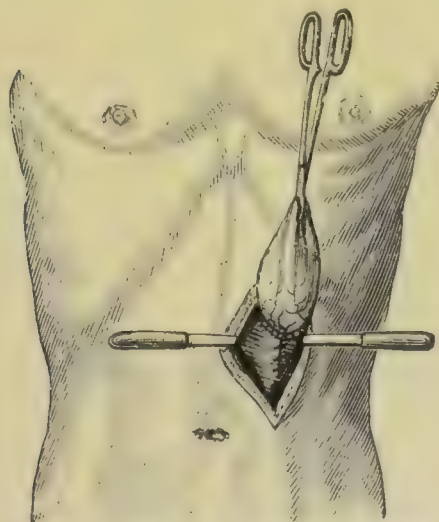


FIG. 433.—Gastrostomy after Albert, Frank, and Kocher.

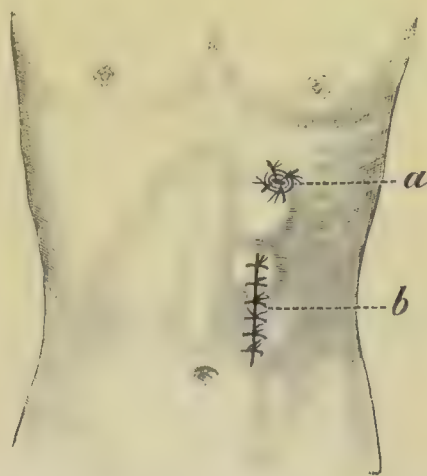


FIG. 434.—Gastrostomy after Albert, Frank, and Kocher: *a*, opening in the stomach; *b*, the sutured abdominal wound.

Closure of Acquired Gastric Fistulæ.—Middeldorpf was the first to heal a gastric fistula by a plastic operation in 1859. Wölfler collected from literature fifty-six cases of acquired gastric fistula. Four were

cured by operation, fourteen closed spontaneously, twenty-seven remained open, and eleven terminated fatally. The external opening of the fistula varies greatly in size, being sometimes as small as the head of a pin, and sometimes presenting a large defect. The fistulæ are in part direct (labiform) and in part indirect. In the former the opening in the stomach wall is directly adherent to the skin, while in the latter the fistula opens in the first place into an abnormal cavity, and a fistulous tract runs outward from here. The causes of acquired gastric fistulæ are either wounds or inflammatory and ulcerative perforations. The condition of the patient depends essentially upon the size of the fistula. The larger the defect the more likely is the food that enters the stomach to escape externally, and the more seriously is the nourishment of the patient interfered with.

The smallest fistulæ are sometimes cured by the use of nitrate of silver or the thermo-cautery. In case of larger gastric fistulæ a plastic operation is often necessary, those of Middeldorpf and Billroth being the best. Middeldorpf formed at the lower border of the fistula a bridge-shaped flap of skin, detached it from the subjacent parts, pushed it over the fistula, and united it with the upper freshened margin of the latter. Billroth undermined a large bridge-shaped flap and allowed its under surface to granulate, and then gradually cut through one bridge, so that the circulation of the flap did not suffer. After a fortnight the granulating cutaneous flap was sutured to the previously freshened margins of the fistula and healed by primary union. After six months, however, a small fistula developed, and in a fortnight the transplanted cutaneous flap had been completely digested by the gastric juice, so that the patient was again in his previous condition. After various attempts to close the fistula proved fruitless, Billroth detached the stomach from the abdominal wall and closed the opening with Lembert sutures. The defect in the abdominal wall was closed by means of a pedunculated skin flap. The cure was a complete one. Billroth cured a second case by transplanting a bridge-shaped, granulating skin flap, suturing it, like Middeldorpf, to the upper border of the freshened defect, and inserting a catheter in the fistula to avoid the digestive action of the gastric juice. The catheter was brought out below the flap.

Resection of the Stomach or the Pylorus.—Resection of the stomach is performed chiefly for carcinoma near the pylorus, and we shall therefore occupy ourselves here only with resection of the pylorus. Other resections—e. g., in the vicinity of the fundus for carcinoma, sarcoma, or ulcer of the stomach—are performed like ordinary gastrotomy (see page 85).

Aside from carcinoma, pylorotomy has been performed for cicatricial stenosis following ulcer of the stomach (Rydygier). Pyloroplasty after Heineke and Mikulicz is usually preferable in this condition, and consists in longitudinal division of the stricture to the extent of at most eight centimetres (Braun) with subsequent transverse suture of the wound. The cicatrix is excised if necessary. Loreta recommends opening the stomach near the constricted pylorus, dilating the latter as much as is necessary with the finger and instruments—e. g., a uterine dilator—and then closing the opening in the stomach. Permanent cures have really been effected in this way. I prefer pyloroplasty, after Heineke-Mikulicz, to Loreta's method. It secures better and more permanent results. Gastro-enterostomy may also be employed for stenosis of the pylorus.

Pylorotomy was earlier recommended—e. g., by Merrem—upon the ground of experiments with animals; but the credit belongs to Billroth and his assistants, Gussenbauer, Winiwarter, Czerny, and Wölfler, of having first proved the practicability of the operation by experiments on animals and successful attempts on man, and of having developed the technique. The first pylorotomy was performed upon the human subject by Péan in 1879. It terminated fatally. Billroth did the first successful pylorotomy in 1881, and Czerny the first successful excision of an ulcer of the stomach in 1882.

Pylorotomy is an operation that involves great risk to the patient's life. In spite of the use of the strictest aseptic methods, many patients have died from the operation mainly in consequence of its long duration. The mortality of the operation is, according to Dreydorff, 57·4 per cent; according to Zeller, from 1881 to 1885, 61·4 per cent, and from 1886 to 1892, 34·3 per cent. The more skilled and the quicker an operator is, the more confidently may he look for a favourable termination. Billroth and Krönlein were particularly successful. The final results of the operation as regards the permanent cure of a carcinoma of the stomach are very unfavourable. After a comparatively short period of temporary good health, death usually occurs from recurrence attended with all the former symptoms. Only in rare cases of early operation is a permanent cure possible. Billroth, Wölfler, Rydygier, and Kocher have observed cures lasting from two years and six months to five years and three months. If a carcinoma of the pylorus can be felt through the abdominal wall, it has already involved the wall of the stomach and the duodenum, and invaded the lymph passages of the peritonæum to such an extent that a cure by operation is usually not to be expected. It is accordingly of the greatest importance to operate as early as possible in every carcinoma of the pylorus. In this incipient period of

the disease, however, a sure diagnosis is usually impossible, and, above all, the discomfort of the patient is so slight that neither the surgeon nor the patient can decide to have the operation performed.

In the later stages of carcinoma of the stomach pylorectomy is contra-indicated. When the operation was first recommended it was repeatedly undertaken in cases in which the disease was far advanced, but at the present time it is much more rarely performed. In the later stages of pyloric carcinoma the sufferings of the patient arising from stricture of the pylorus can be relieved by performing gastro-enterostomy.

In every case of carcinoma of the pylorus one should inform himself by careful and repeated examination of the patient—if necessary, under an anæsthetic, as to the relations of the tumour. For ascertaining whether an existing tumour belongs to the stomach, the inflation of the latter with air or gas may be utilized with the greatest advantage (Angerer). An India-rubber tube, provided with a double bellows, is passed into the stomach and air pumped in, or a solution of six or seven grains of bicarbonate of soda and a solution of five or six grains of tartaric acid are given in rapid succession, so that carbonic-acid gas is set free in the stomach. If pylorectomy is decided upon, the same preliminaries are necessary by way of preparing the patient as in any laparotomy (see page 45). The stomach should be washed out repeatedly for several days, and then again two hours before the operation. Attention must be paid also to the most thorough evacuation of the intestinal canal.

The Technique of Pylorectomy is as follows: The operation consists of five parts: 1, Opening the peritoneal cavity; 2, finding and isolating the pylorus; 3, excision of the pylorus; 4, uniting the stump of the stomach with the duodenum; 5, suture of the abdominal wound.

The peritoneal cavity is opened, in accordance with the rules for laparotomy given on page 46, by dividing the abdominal wall by layers, the incision being made, according to the position and degree of mobility of the tumour, either in the linea alba from the xiphoid process to the umbilicus (Péan, Rydygier, the author), or along the outer border of the right rectus muscle (Fig. 435, 4, the author), or obliquely, after Billroth and Wölfler (Fig. 435, 2 and 3). The skin incision should be about ten or twelve centimetres long.

After the peritoneal cavity has been opened, one ascertains first of all the extent of the carcinoma and to what degree the pylorus is adherent to the adjacent parts, especially to the pancreas and the transverse colon. In this way it is determined whether extirpation is possible. If the carcinoma involves too much of the stomach and the

duodenum—e. g., has grown beyond the horizontal part of the latter or into the hepato-duodenal ligament, in which, as is well known, the large hepatic vessels and the biliary ducts are situated—or if the adhesions are too extensive, the operation should be carried no further. One may then, if necessary, try to relieve the symptoms arising from stenosis by means of gastro-enterostomy.

If pylorectomy is decided upon, the tumour is next isolated. The stomach is drawn as far as possible into the wound and covered with warm and moist compresses. Hereupon the great and the lesser omentum are detached from the upper and lower curvatures of the stomach. The part of the great omentum connecting the stomach and the transverse colon—viz., the gastro-colic ligament—is first detached as far as necessary near the greater curvature by dividing it with scissors or the thermo-cautery between double ligatures *en masse* of fine silk. The detachment of the lesser omentum at the upper border of the stomach and the pylorus is then accomplished in the same way. In doing this, small sections are tied off successively by means of double ligatures of fine silk and divided between the latter. The separation of the mesocolon from the transverse colon, in case it is adherent to the posterior wall of the stomach, demands the greatest care.

If the mesocolon has to be detached from the transverse colon for any great distance on account of adhesion with the posterior wall of the stomach, gangrene of the colon is to be feared (Lauenstein, Küster, Czerny, and others), and for this reason the operation should be abandoned. One might, it is true, resect the part of the colon which is deprived of its mesocolon, and then unite the ends of the gut by circular enterorrhaphy. Lauenstein avoided gangrene of the colon in a case of non-malignant stenosis of the pylorus by detaching the serous layer of the posterior surface of the pylorus together with the adhesions clinging to it, and thus preserving the blood-vessels of the mesocolon. Any enlarged lymph glands that are found in isolating the pylorus are of course removed at the same time.

After the pylorus or the tumour has been isolated on all sides, the stomach is brought completely outside the peritoneal cavity and placed upon a flat aseptic sponge, or, better, upon a large, warm gauze pad, by which the rest of the peritoneal cavity is completely

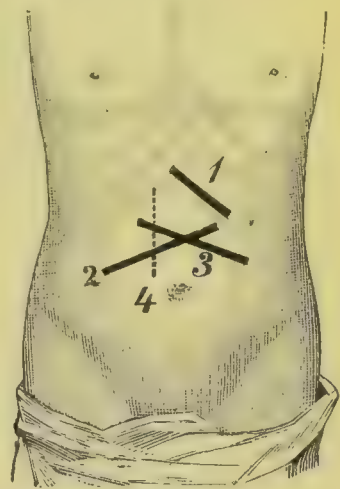


FIG. 435.—Incisions for operations on the stomach: 1, incision for gastrostomy; 2 and 3, oblique incisions after Billroth for pylorectomy; 4, incision along the outer edge of the rectus for pylorectomy.

shut off, so that the operation can now be completed extra-abdominally.

Before the pylorus is severed from the duodenum and the stomach by two oblique incisions, as shown in Fig. 436, both the stomach and the duodenum must be constricted, so that none of the contents of either may escape into the peritoneal cavity. This may be accomplished either by the fingers of a good assistant or by means of the clamps shown in Fig. 437, or by a loop of silk.

The pylorus is now seized with a volsellum forceps which is held by an assistant. Section of the gastric end of the pylorus is then begun at the lesser curvature, and is made in an oblique direction with scissors (Fig. 436). All spurting vessels are immediately caught with artery clamps, and the contents of the stomach that may escape are removed at once by means of aseptic pads. The stomach is not completely severed from the pylorus, but one retains for the

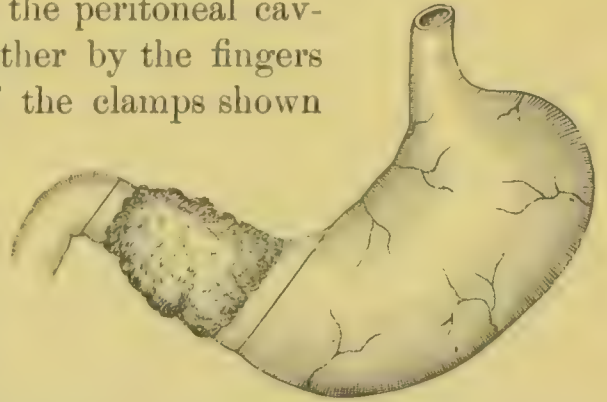


FIG. 436.—Pylorotomy for carcinoma of the pylorus.

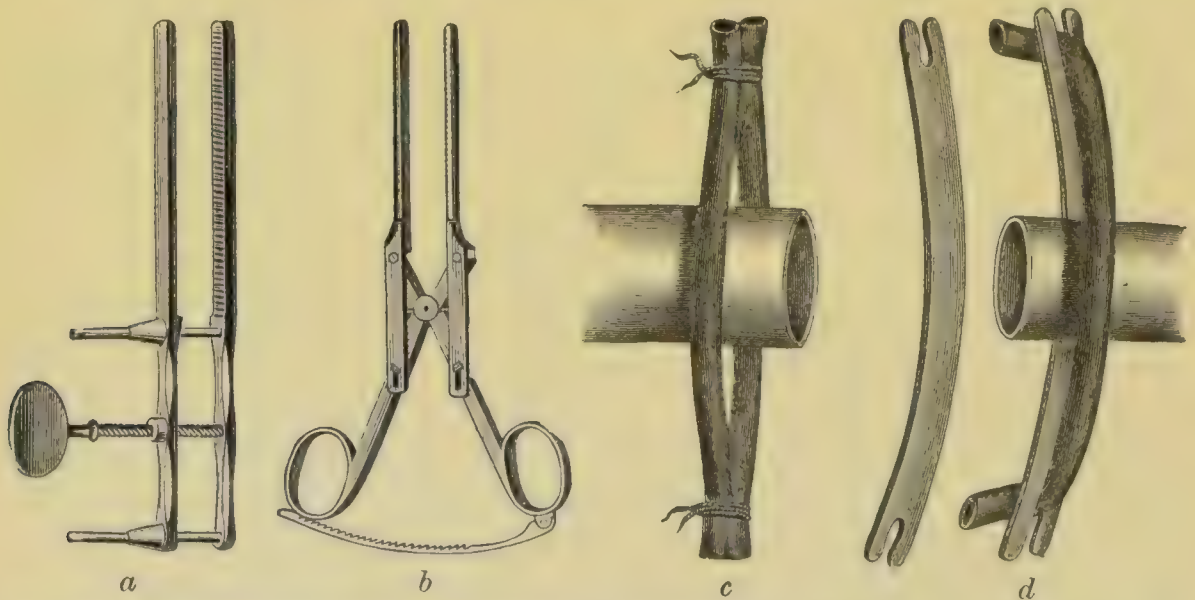


FIG. 437.—Clamps for compressing the stomach and intestine in pylorotomy: *a*, after Billroth; *b*, after Gussenbauer; *c*, after Rydygier (steel rod covered with a rubber tube); *d*, after Heineke.

time being about as much as corresponds to the diameter of the duodenum. Dissection back of the serous and muscular coats from the mucous membrane before the latter is cut (Kummer, Kocher) is strongly to be recommended in resection of the stomach and intestine, on account of the more complete removal of all the diseased tissue and

the better arrest of the hæmorrhage. After ligation of the vessels in the edge of the incision, the latter is closed at once by a continuous suture of fine silk which includes only the serous and muscular coats. Above this a second row of continuous silk sutures is applied.

Section of the stomach is now completed, and after careful hæmorrhage the duodenum is severed from the pylorus, likewise in an oblique direction. The hæmorrhage having been arrested, the last stage of



FIG. 438.—Suture of the duodenum into the greater curvature of the stomach after section of the pylorus.

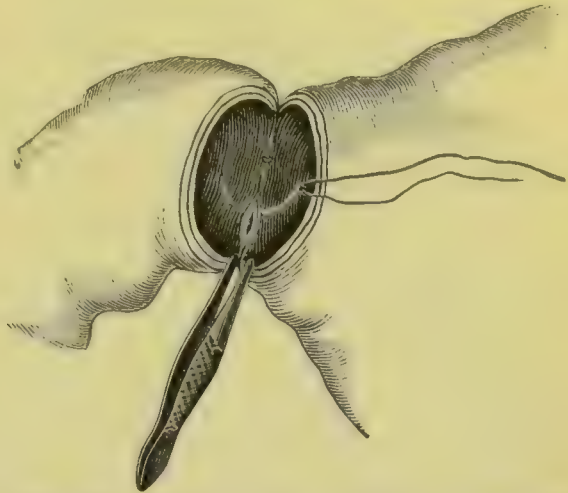


FIG. 439.—Suture of the mucous membrane from within after Wölfler.

the operation now follows—viz., suture of the duodenum to the stomach near the greater curvature (Fig. 438). The best method of suturing is to apply at first, as far as possible, a continuous suture from within with fine silk, which includes the muscular and serous coats, and then a second row of sutures from without, likewise including only the serous and muscular coats. A continuous suture can be applied much more quickly than interrupted sutures and it is perfectly secure. Any weak points can be re-enforced by additional sutures. Some surgeons unite the edges of the mucous membrane by interrupted sutures partly from within and partly from without (Fig. 439).

The attachment of the duodenum to the lesser curvature (Fig. 440 *a*) or to the middle of the wound in the stomach (Fig. 440 *b*) is less advisable than its attachment to the greater curvature.

Kocher closes the wound in the stomach completely and sutures the stump of the duodenum into a new opening made in the posterior stomach wall. Murphy's button can here be used with advantage.

Finally, the line of suture is carefully tested and the parts are thoroughly disinfected and replaced in the peritoneal cavity after removal of the gauze pad. The abdominal wound is closed in the way described on page 47.

For the combination of gastro-enterostomy and gastro-duodenostomy with pylorotomy see page 99.

The after-treatment of the patient consists mainly in giving opium and in feeding him during the first few days after the operation by

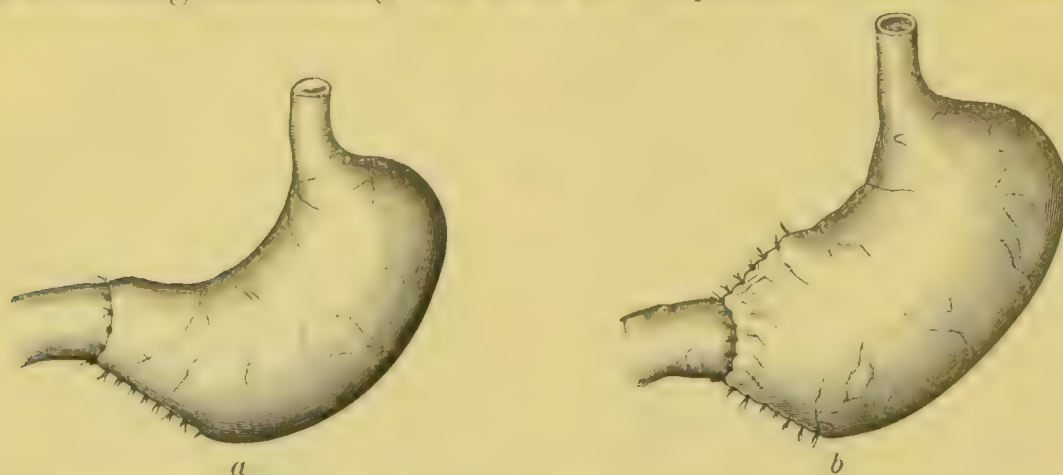


FIG. 440.—Pylorotomy: *a*, suture of the duodenum into the lesser curvature; *b*, suture of the duodenum into the centre of the wound in the stomach.

means of enemata. Broken ice and wine may be given on the second day. After the fourth day a fluid diet is allowed, but nothing solid before the eighth day.

Resection of the cardiac end has never been performed on the living human subject. W. Levy has done the operation on the cadaver and on live dogs, and recommends it for the human subject. Division of both vagi nerves, which are adjacent to the cardiac end, had no evil consequences (Krehl).

Gastro-enterostomy (Fig. 441), or the union of the cavity of the stomach with a loop of small intestine which has as high a location as possible, was first performed by Wölfler. The operation is indicated in case of inoperable carcinoma of the pylorus, combined with symptoms of extreme stenosis, and also after such extensive resection of the pylorus that the stomach and the duodenum can not be united (see Fig. 443).

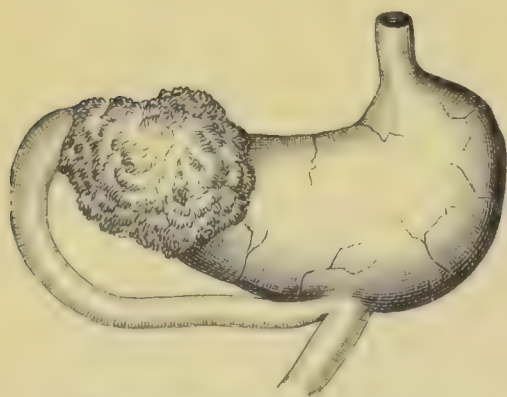


FIG. 441.—Gastro-enterostomy (diagrammatic).

Küster cured permanently two cases of ulcer of the stomach situated near the pylorus with stenosis of the latter, by cauterization of the ulcer

and gastro-enterostomy. The mortality of gastro-enterostomy is, according to Dreydorff, 43·3 per cent, and when combined with pylorotomy 60 per cent. Zeller found that the mortality of gastro-enterostomy from 1881 to 1885 was 70 per cent, and from 1886 to 1892 only 38·7 per cent.

The patient is prepared by thorough evacuation of the bowels, lavage of the stomach, and an opium enema given just before the operation. After the peritoneal cavity has been opened in the linea alba, from the xiphoid process to the umbilicus, one looks for the greater curvature of the stomach, and draws out a loop of the jejunum that seems best suited for attachment to the stomach. According to Lücke and Rockwitz, it is not necessary that a loop should be chosen that is as near as possible to the duodenum, but, on the other hand, one must not select a part of the intestine that has too deep a location, as the patient may then die of inanition, as occurred, for example, in a case of Lauenstein's. It is better, therefore, beginning at the duodeno-jejunal junction, to choose a loop of the jejunum which can be attached to the stomach conveniently and without constricting the transverse colon. The duodenum is easily found by displacing the stomach and the transverse colon upward, and then passing along the mesocolon to the spinal column. The jejunum may easily be drawn forward to the left of the latter (Czerny). The loop of small intestine may either be drawn over the transverse colon to the stomach (Wölfler), or, better, passed through a vertical slit in the transverse mesocolon near the greater curvature, or through the mesocolon and the gastro-colic ligament (Billroth, Hacker). Before the small intestine is opened, its afferent and efferent ends are closed by a circular loop of silk or by a clamp (see Fig. 437, page 94). The opening in the stomach, a few fingers' breadth above the insertion of the gastro-colic ligament and not too near the pylorus, may be kept closed by an assistant. The opening in the stomach and the intestine should be four or five centimetres long. Rockwitz deems it important that the intestine be united with the stomach in such a way that the peristalsis of the two shall have a parallel course—that is, that the afferent part of the former be sutured to the left and the efferent part to the right angle of the incision in the stomach. Wölfler recommended the opposite attachment. Upon touching the intestine with a crystal of common salt, a peristaltic wave running upward in the direction of the pylorus occurs (Nothnagel), so that the direction of the loop of intestine can be determined in this way. The suturing is done upon a warm, sterilized-gauze compress placed beneath, by which the rest of the peritoneal cavity is shut off. Here also continuous sutures of fine silk are preferable. One may first unite the posterior edges of the openings in the stomach and intestine from within as far as possible by sutures passing through the muscular and serous coats. The anterior edges should then be united from without, likewise including only the serous and muscular coats. A second continuous suture is then

inserted from without, including only the same coats as before. It is also a good plan to unite at the beginning the stomach and intestine by a continuous suture or a row of Lembert sutures, then to open the stomach and intestine, and complete the double row of sutures. Braun and Roux recommend that, after the intestine has been attached by a few sutures to the stomach, an incision be made in each two or three millimetres from the line of suture down to the submucous layer, so that a second row of sutures may be applied through the serous and muscular coats, and that the mucous membrane be then opened, and a third row of sutures made to unite the mucous membrane of the stomach and the intestine. The opposite edges are then united in reversed order. This method may be used in other operations upon the stomach and intestines. Courvoisier first attaches the afferent part of the intestinal loop to the wall of the stomach, then opens the efferent part, and unites the edges of the incisions in the intestine and the stomach. In this way the entrance of bile and pancreatic juice into the stomach is supposed to be prevented, because, as a result of the elevation of the upper wall of the intestine, the passage of the intestinal contents along its steep lower wall is facilitated. To prevent disturbances in the propulsion of the contents of the stomach or the intestine, H. Braun made, with satisfactory results, an anastomosis between the two limbs of the loop of the jejunum that is attached to the stomach. Jaboulay made an anastomosis between the duodenum and the jejunum in a similar way and for the same purpose (jejuno-duodenostomy). Kocher has devised an excellent method, shown in Fig. 442. This is probably the best way of preventing regurgitation of the intestinal contents into the stomach.

For a description of Senn's plates and Murphy's button, see page 124. The latter device shortens gastro-enterostomy very materially.

Gastro-enterostomy is not infrequently followed by a marked narrowing or even complete closure of the fistulous opening. In order to prevent this, Chaput recommends a valvular anastomosis: The stomach and intestine are united for a distance of from six to eight centimetres by means of sutures through the serous coats; the stomach and intestine are opened in front of this line of suture in a transverse direction for a distance of six centimetres, and two vertical incisions are made at the end of these, so that an **H** results. The anterior and posterior flaps thus formed are then united along their three free edges, first by sutures through the mucous membrane, and then through the serous coat. McGraw also makes a flap in the stomach and intestine by means of a **Π**-shaped incision. Sonnenburg attempted to prevent a narrowing of the fistulous opening by drawing a portion of the stomach wall into the intestine, and uniting it in this position with Lembert sutures.

(For details, see *Deutsche Zeitschrift für Chirurgie*, Bd. xxxviii, p. 296, and *Centralblatt für Chirurgie*, 1894, p. 916.)

Billroth combined pylorectomy with gastro-enterostomy. If so extensive a resection of the pylorus has been made that the duodenum and the re-

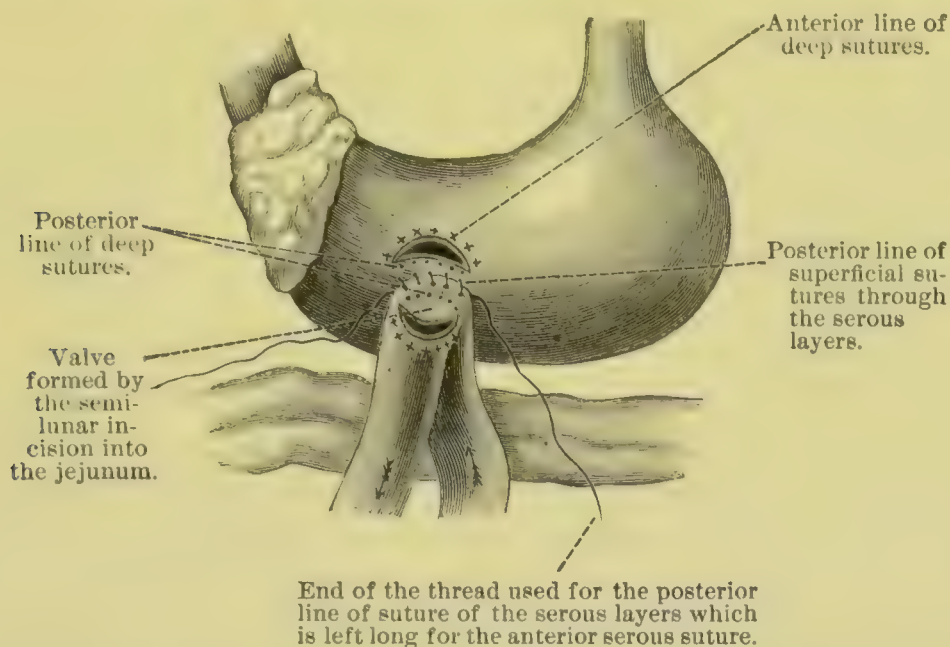


FIG. 442.—Kocher's gastro-jejunostomy: The jejunum is attached to the stomach in such a way that the afferent portion of the intestine *ascends* perpendicularly and the efferent portion *descends* perpendicularly. A flap is formed from the wall of the intestine by a semilunar incision for the purpose of obtaining a valvular closure.

mainder of the stomach can not be united, one may invert the edges of the wound in the stomach and the duodenum, and close both organs by two or three rows of a continuous suture, including the serous and muscular coats. Gastro-enterostomy is then performed (Fig. 443, after Hacker). Kocher recommends inserting the end of the duodenum in an opening in the stomach that is made especially for it (gastro-duodenostomy).

In cases in which pylorectomy can not be performed, Langenbuch and Southam have formed an external duodenal fistula (duodenostomy) in place of gastro-enterostomy. In the three cases thus treated the patients died soon after the operation, in consequence of impaired nutrition, probably because the bile and the pancreatic juice did not perform their functions sufficiently. Maydl and Hahn recommend performing duodenostomy, or, preferably, jejunostomy instead of gastro-enterostomy in cases of carcinoma of the cardiac end with a markedly contracted stomach which can not be drawn into the wound; also in case of a burn of the stomach with sulphuric acid, for example, and in hæmorrhage from inaccessible gastric ulcers. The operation may be performed as

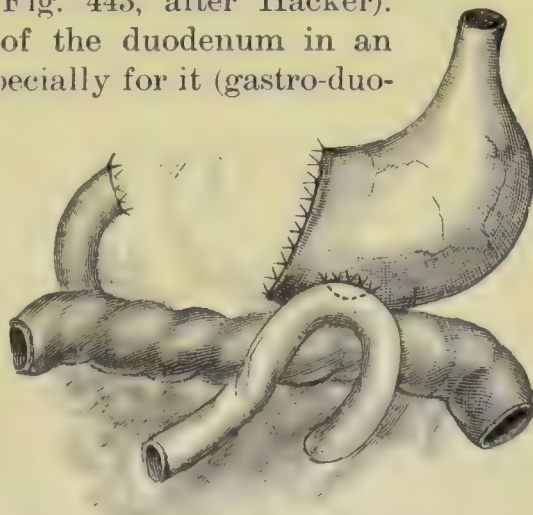


FIG. 443.—Pylorectomy combined with gastro-enterostomy.

follows: The peritoneal cavity is opened below the ensiform process by a transverse incision, and the small intestine (duodenum, jejunum) also divided transversely fifteen to twenty centimetres distant from the duodeno-jejunal junction. Both ends are drawn out and the peritoneal cavity shut off by temporary sutures. The intestine is incised longitudinally on the convex side ten centimetres below the orifice of the distal end, answering to about half the circumference of the small intestine, and the proximal end is sutured at this point into the lower segment, so that the passage of bile and pancreatic juice into the small intestine goes on undisturbed. The distal end is finally drawn somewhat out of the abdominal wound and fixed in the left corner of the latter by means of interrupted sutures, or a safety pin stuck transversely through the wall of the intestine. Albert makes an anastomosis between the afferent and efferent portions of the loop of jejunum, then draws the latter four centimetres upward beneath a bridge of skin, as in performing gastrostomy (see page 89), and sutures it here.

It is of practical importance that symptoms of stenosis of the stomach occur in rare cases in consequence of flexion and kinking of the same caused by adhesions and bands, especially when the stomach is very full (Birch-Hirschfeld, Hacker). Extremely painful attacks of colic are not infrequently caused by adhesions of the gastro-intestinal canal. The division of the adhesions is sufficient in all such cases, combined if necessary with suture of the intraperitoneal wound surfaces, to avoid new adhesions. Angerer and Ziegler observed a large traumatic cyst of the stomach wall, and cured it by laparotomy and puncture.

The disturbances caused by a so-called "hour-glass" stomach may in some cases be remedied by performing gastric anastomosis (Wölfler)—i. e., establishing a communication between both sacs by means of a second sufficiently large opening. In cases of dilatation of the stomach, Brandt diminishes the size of the organ by infolding and suturing its peritoneal and muscular coats ("gastroplicatio").

§ 166. **Foreign Bodies in the Stomach and Intestine.**—Foreign bodies most frequently gain access to the stomach and the intestinal canal through the œsophagus. The greatest variety of bodies have been found, especially fruit stones, splinters of bone, beads, buttons, needles, artificial teeth and sets of teeth, knives, forks, small spoons, etc. Stelzner removed numerous pieces of wood from the intestine of an insane person. Schönborn extracted from the stomach of a hysterical patient a large, solid ball of hair which was shaped like the stomach, and had resulted from the fact that the woman had long had a habit of eating her hair. Needles are often swallowed in large numbers by hysterical persons or stuck beneath the skin. Fatal hæmorrhage from the stomach has been observed in consequence of swallowing leeches.

Other foreign bodies, such as bullets and knife blades, gain access

to the gastro-intestinal canal through wounds, while others are introduced into the rectum. Criminals in prison sometimes conceal in the rectum money or instruments which they wish to use in attempts to escape, especially files or cases containing such instruments. Masturbators and prostitutes not infrequently introduce large objects into the rectum to increase the pleasure of coitus. Other bodies are formed in the intestine itself—e. g., fæcal concretions, resulting from the hardening of fæcal masses. I removed from the rectum of a tabetic patient, with great difficulty, after breaking it up with a crushing forceps and with the hand, a very hard fæcal concretion as large as the fist. One sometimes finds intestinal concretions (enteroliths) composed of phosphate of lime and phosphate of magnesia, and also gallstones or renal and vesical calculi which have passed into the intestine. The intestinal concretions (enteroliths) occur, according to Leube, in three principal forms: 1. Round concretions, about the size of a chestnut and as hard as stone, with concentric layers of a white, yellow, and brown colour, consisting of magnesium phosphate, ammonio-magnesium phosphate, and organic ingredients. A foreign body is often found inside as a nucleus (gallstone, fruit stone, etc.). 2. Intestinal concretions resulting from the long-continued use of chalk or magnesia—e. g., among persons who frequently take carbonate of magnesia for chronic constipation. Friedländer saw intestinal concretions of shellac in the case of a cabinetmaker who frequently took a solution of shellac into his mouth. 3. Porous, semi-soft concretions, which are composed of interwoven undigested vegetable remains with deposits of earthy and calcareous masses. Many fæcal concretions consist mainly of fruit stones—e. g., cherry stones or plum stones. Thus Cruveilhier found in a man's large intestine, at an autopsy, an enormous fæcal concretion which consisted of six hundred and seventeen cherry stones. Intestinal concretions are particularly common among horses and cattle, and they here attain a very large size.

The symptoms and the course of foreign bodies in the gastro-intestinal canal depend essentially upon the size and the nature of the body. The objects are frequently eliminated by vomiting, or evacuated *per rectum* without doing any harm. Large bodies even have passed through the intestinal tract and been discharged *per anum* without injury. Nussbaum mentions several almost incredible cases. He says, for example, that four sailor's knives, a clay pipe three and a half inches long, a silver fork, several large pieces of glass, a box containing letters, etc., passed off in this way *per rectum*. A juggler swallowed a sword a yard long which was broken into three pieces, two table knives, a razor, a flint, coins, keys, etc. All passed off *per rectum* without injury. An observation by Bloch which Esmarch mentions in his Diseases of the Rectum sounds almost incredible. The following objects,

which had been swallowed by an insane person, passed off *per rectum* in eight months: 157 sharp, angular pieces of glass up to five centimetres in length, 102 brass pins, 150 rusted iron nails, 3 large hairpins, 15 pieces of iron of varying size, a large piece of lead, half a brass shoe buckle, and 3 tent hooks.

Often, however, the foreign bodies remain in the stomach or intestine, occasioning intestinal obstruction, and they may, by perforation of the digestive tract, produce fatal general peritonitis. If adhesion with the surrounding parts takes place before perforation of the stomach or the intestine, and if an encapsulated abscess is formed, the foreign body may in this way be discharged spontaneously or after incision of the abscess. Even large foreign bodies, such as knife blades and spoons, have thus worked their way outward with a favourable termination months after they were swallowed. Sewing needles can pass through the intestinal wall without causing a perforation of the intestine. Otto, in Copenhagen, extracted in the course of three years from the most varied parts of the body three hundred and ninety-five needles which had been swallowed by a woman. Eiloy removed nearly a thousand needles from the vagina, the thighs, and other parts of the body, which had been swallowed by an insane girl. Foreign bodies sometimes pass from the gastro-intestinal canal into other organs—e. g., into the bladder after previous adhesion of the intestine with the latter. The abnormal communication thus formed between the intestine and the bladder either persists or the fistula closes. In the bladder the body usually gives rise to the formation of a calculus, inasmuch as urates are deposited about it.

The foreign bodies remain lodged in the intestine at certain favourite places—e. g., at the point of flexion of the duodenum, at the Bauhinian valve, in the vermiform appendix, at one of the flexures of the large intestine, at the so-called third sphincter of the rectum, and above the anal opening. Death ensues most frequently, no doubt, from perforation of the vermiform appendix, in consequence of a small foreign body that has entered it. The fatal termination sometimes occurs suddenly later in life in consequence of perforation of the appendix with general septic peritonitis.

The prognosis of foreign bodies in the gastro-intestinal canal is always dubious. The larger, more pointed, more angular, and sharper edged the foreign body is, the more uncertain is its spontaneous elimination *per rectum*. That very small bodies may cause death by perforation of the vermiform appendix is well known. Large bodies, on the other hand, are often passed without harm when one would have deemed it impossible (see also Foreign Bodies in the Rectum).

Treatment of Foreign Bodies in the Gastro-intestinal Canal.—When poisons have been swallowed, either in solid form or in solution—e. g., a nitrate-of-silver stick, sulphuric acid, carbolic acid, etc.—the stomach should be thoroughly washed out as quickly as possible (see page 84). After nitrate of silver has been swallowed, the patient should in addition drink salt water, in order to precipitate chloride of silver. Poisonous acids are neutralized by a solution of bicarbonate of soda; and in case of alkalies, on the other hand, acids are given, so as to

form harmless salts. By giving oil, saponification is brought about. The patient should always drink a large amount of fluid, so as to dilute as far as possible the concentrated material.

In case of solid bodies, the treatment depends chiefly upon their size and form. In case the foreign body is large, pointed, or angular, can be felt at a particular part of the intestinal tract, and is such that its passage through the intestine is impossible or attended with danger, gastrotomy (page 85) or enterotomy (page 121, § 169) should be performed and the body extracted from the stomach or the intestine. The passage of the foreign body through the intestine and its discharge *per rectum* should be aided by giving abundant food calculated to envelop the body, as it were—e. g., rice cooked in milk, potatoes prepared in various ways, beans, etc. Cathartics are not advisable. If pain occurs anywhere in consequence of the impaction of the foreign body and abscess formation is threatened, the development of adhesions should be favoured by giving opium. In such cases, however, one must not wait too long before performing laparotomy.

Gastrotomy is especially indicated when there is a large, pointed, angular, sharp-edged body in the stomach, whose harmless passage through the intestine is improbable, and also when there is severe pain, or when abscess formation and perforation of the stomach are threatened.

The same indications hold good for the operative removal of the foreign body by enterotomy. In case of intestinal obstruction, and when perforation of the intestine and general peritonitis already exists, one should endeavour to save the patient by performing laparotomy as quickly as possible. Laparotomy may likewise become necessary in case of abnormal communication between the intestine and the bladder, for instance, with the serious disturbances conditioned thereupon. In case of an abscess about the foreign body, which is not as yet adherent to the abdominal wall, the operation may be performed in two stages—that is, laparotomy is performed and adhesions brought about between the abscess and the abdominal wall, and then, after from four to six days, the former is opened. The removal of a foreign body from an abscess, which is already adherent to the abdominal wall or even lies within the latter, may be very simple. Upon incision of the abscess, the foreign body often appears at once.

Malformations of the Intestine.—Large defects and even complete absence of the intestines have been occasionally observed in certain monstrosities (acardiaci). We have already mentioned (§ 154, page 11) the development of defects from the constriction of intestine within a congenital umbilical hernia, also ectopia of the abdominal organs, and Meckel's diverticulum.

Regarding the abnormal position of the intestines in cases of congenital hernia, I refer the reader to the latter. We shall take up congenital malformations of the rectum and the anus more in detail in connection with the surgery of the rectum.

(For injuries of the intestine, see §§ 155 and 156.)

§ 167. **Inflammatory Processes in and about the Intestines.**—Of the inflammatory processes in and about the intestines we shall here take up only those which are of surgical interest, and these only in so far as they cause perforation of the intestine with localized or general peritonitis.

Perforations of the intestine are caused by injuries (see §§ 155, 156), acute and chronic inflammations of the intestines, terminating in ulceration—e. g., typhoid fever, tubercular enteritis, diphtheritic inflammation, and by foreign bodies, etc. After perforation of the intestine there is either a free escape of the intestinal contents into the peritoneal cavity, with general septic peritonitis, or the site of the perforation is shut off by adhesions with the neighbouring organs, especially with the surrounding intestinal coils and the abdominal wall, and a circumscribed faecal abscess ensues. Such inflammations leading to perforation of the intestine occur at all parts of the same, especially in the duodenum (duodenitis), in the ileum (ileitis), in the cæcum and the vermiform appendix (typhlitis, perityphlitis, and appendicitis), in the large intestine (colitis), and in the rectum (proctitis and periproctitis). Regarding the latter, the reader is referred to the surgery of the rectum.

Perityphlitis and Appendicitis.—The inflammations of the cæcum and the vermiform appendix and their vicinity, known as typhlitis, perityphlitis, and appendicitis, are of special surgical interest. Of the inflammations of the cæcum (typhlitis), those which lead to ulceration are the most important surgically, and may occur with or without inflammation of the vermiform appendix. The latter is more frequently, however, the starting point of the inflammation. We designate the inflammatory process in the neighbourhood of the cæcum as perityphlitis. The inflammation of the connective tissue which unites the posterior surface of the cæcum with the iliac fascia is also called, after Virchow, paratyphlitis. The anatomy of the cæcum and the vermiform appendix is of the greatest importance for the pathology of typhlitis and perityphlitis or paratyphlitis. The cæcum forms anatomically no separate division of the intestinal tract, but represents merely the beginning of the large intestine. It is usually, like the vermiform appendix, completely covered by peritonæum, or the latter may be absent on its posterior surface. The appendix has an average length

of eight and a quarter centimetres, and reaches its greatest length between the tenth and thirtieth years. The partial or complete obliteration of the appendix should not be regarded as pathological, but as a physiological change which increases with the age of the individual. Out of one hundred persons over twenty years of age there were thirty-two in which the lumen of the appendix was partially or completely obliterated, while in those over sixty more than fifty per cent were in different stages of obliteration (Ribbert). The anomalies in the position of the appendix are of great interest. It either lies free in the abdominal cavity, or frequently behind the cæcum or the beginning of the large intestine, and is either intraperitoneal or partially or wholly extraperitoneal (G. J. Turner). Inflammations in the ileo-cæcal region formerly called perityphlitis usually originate in the appendix, and take the form of a localized peritonitis. The term appendicitis is hence more exact than perityphlitis. We distinguish acute and chronic catarrhal and ulcerative or gangrenous (perforative) appendicitis. The view that a typhlitis can be caused by impaction of faeces is no longer tenable. Paratyphlitis (Virchow) is to be regarded as a retroperitoneal phlegmon which has usually originated from inflammation and perforation of a vermiform appendix that is situated extraperitoneally behind the cæcum. The appendix is very prone to inflammation, whether it be that small foreign bodies become lodged in it or that inflammation of an adjacent part of the intestine extends to it. Small bodies in particular—such as grape seeds, apple seeds, small cherry stones—easily enter its lumen and give rise to the formation of small faecal concretions which erode and perforate its wall and lead to localized or general peritonitis. People in perfect health often die very suddenly in this way from general septic peritonitis. Inflammations of the cæcum which extend to the appendix are likewise either catarrhal or ulcerative, or they may be tubercular, dysenteric, or typhoidal. Kocher and Lang observed two cases of actinomycotic perityphlitis. Complete gangrene of the appendix sometimes occurs. A retention cyst filled with mucus occasionally ensues from adhesion and obliteration of the opening of the appendix (appendicitis obliterans), or, in case of retention of pus and septic material, it may come suddenly to perforation and general peritonitis.

Perforative appendicitis results either in general septic peritonitis or in the formation of a localized appendicular abscess. The course of the latter may be very chronic. A localized abscess may also occur without perforation of the appendix, being due, for example, to catarrhal ulcers, to the absorption of the pus cocci by means of the lymphatics, etc. These encapsulated abscesses may rupture into

the peritoneal cavity, the intestine, the bladder, or externally through the abdominal wall. They sometimes spread upward or downward, following the loose connective-tissue septa, like other gravitation abscesses. They sometimes descend into the pelvis or the iliac fossa, and even farther on to the thigh. In one case upon which I operated the abscess, which was as large as the fist, was on the left side, so that it was opened here above Poupart's ligament. Appendicular abscesses not infrequently extend upward behind the cæcum as far as the diaphragm, and on farther into the thoracic cavity. Large subphrenic faecal abscesses (pyopneumothorax subphrenicus) may develop, followed, after rupture into the thoracic cavity, by empyema (faecal fistulae of the thorax). In other cases an empyema develops in conjunction with perforative appendicitis by infection along the lymph passages, without any apparent continuous connection between the two processes. The course of appendicitis is extremely varied, being sometimes very acute and then again very chronic, much as in carcinoma of the intestine, for example. In every case of inflammation in the vicinity of the cæcum and the appendix a rectal examination should be made.

As regards the prognosis of appendicitis the views are very divergent. Healing takes place by cicatricial contraction of the inflammatory exudate, encapsulation and absorption of small abscesses with disappearance of the appendix, etc. Large abscesses, however, never disappear spontaneously. Recurrent attacks extending over a long period sometimes occur. These recurrences are mainly the result of an incomplete spontaneous cure.

Subphrenic faecal abscesses may develop after perforation of almost any portion of the gastro-intestinal canal. I have already mentioned (vol. ii, § 124, page 694) a case of subphrenic faecal abscess which had probably developed from perforation of the duodenum, and which I cured by thoracotomy after it had ruptured into the thoracic cavity.

The symptomatology of intestinal perforation varies according as general or localized peritonitis follows. In case of localized peritonitis the area involved is painful, especially on palpation, and the percussion note is usually dull. If the circumscribed abscess contains gas, or is covered by intestines, the percussion note is usually without peculiarity—that is, tympanitic. There is always more or less marked fever present. The nearer the focus of inflammation lies to the abdominal wall, the more is the latter infiltrated. The most important symptoms, however, are always those on the part of the intestine itself. Symptoms of stenosis, sometimes amounting even to complete occlusion of the bowel, always attend intestinal perforation. This stenosis of the in-

testine is conditioned in part upon the local compression of one or several intestinal coils by the inflammatory tumour, the abscess, and in part upon flexion or fixation of the intestine in case of local or general peritonitis. Severe symptoms of intestinal obstruction may appear very quickly, in consequence of the stenosis or complete occlusion of the intestine—that is, faecal vomiting, drumlike distention of the abdomen, and rapid collapse, such as is characteristic of general peritonitis. In all such cases the differential diagnosis with reference to the real cause of the obstruction is often very difficult, and it is frequently the case that only laparotomy or the autopsy can determine whether it is a case of perforation of the intestine or of internal strangulation caused by volvulus or intussusception, etc. (see § 168, page 112).

With reference to the symptomatology of subphrenic faecal abscesses (pyopneumothorax subphrenicus) and rupture of the same into the thoracic cavity (pleura, lungs, mediastinum, pericardium), the reader is referred to vol. ii, § 124, page 694. The fistulous communications between the thoracic and peritoneal cavities resulting from perforation of the gastro-intestinal canal are there mentioned also.

Aside from perforation into adjacent organs and erosion of large blood-vessels, rupture into the peritoneal cavity with secondary general peritonitis is always to be feared in connection with circumscribed encapsulated faecal abscesses.

The treatment of perforation of the intestine resulting in a circumscribed faecal abscess or general septic peritonitis conforms to the same principle that we have given (§ 158, page 38) for the treatment of peritonitis. In case of a faecal abscess that is adherent to the abdominal wall, incision and drainage are sufficient. The reader is referred for the technique of laparotomy in case of perforation of the intestine, attended by general peritonitis, to page 38 and pages 45–47. The opening in the intestine is finally closed by Lembert sutures after freshening the borders of the defect, or it may be necessary to resect the entire diseased portion of the intestine and unite the ends by circular enterorrhaphy (see § 169, page 121 ff., Technique of Intestinal Suture). In case of perforation of the appendix the latter is removed. With reference to the search for an intestinal perforation, the reader is referred to pages 117. We shall take up more in detail the treatment of faecal fistulæ on page .

The treatment of typhlitis, perityphlitis, and appendicitis has been of late the subject of animated discussion (Bergmann, Mikulicz, Sonnenburg, etc.). Some surgeons, including Sonnenburg and Kümmel, have taken ground in favour of early operative treatment in case of evident tumour formation or suppuration in the vicinity of the appendix. Other

surgeons favour an expectant treatment (opium, ice, etc.). The advisability or inadvisability of operating has to be decided for each case. I am in favour, generally speaking, of early operation in case of evident localized inflammation—i. e., tumour formation or exudation in the vicinity of the appendix. By waiting too long one often loses the possibility of saving the patient. In fifty-two of Sonnenburg's cases operated on early, pus was found in every one. In cases of recurrent appendicitis an operation is, in my opinion, indicated if there are frequent attacks and constant disturbances are present, even in the interval. The prognosis of operative interference is then usually favourable, and the appendix should be removed. Out of eighty cases operated on by Sonnenburg, twenty were recurrent. It is to be lamented that the surgeon is often called in too late for the treatment of appendicitis. It would be far preferable if its treatment were placed in the hands of the surgeon. The operation consists in evacuating the abscess after an exploratory puncture, finding the appendix, and, when practicable, removing it completely. The operation may be performed in two stages. The cutaneous incision begins close to the bone, just above the anterior inferior spine, and runs with a slight curve to about the middle of Poupart's ligament. Through this incision one can easily reach the ordinary periappendicular abscess, as well as any pus lying behind the cæcum and colon, particularly if the peritonæum is separated sufficiently from the iliacus muscle. Any pus that has burrowed upward along the colon toward the liver or downward about the bladder and rectum can be removed through the same incision. The after-treatment consists in packing the cavity with iodoform gauze. Bryant recommends making the incision farther backward between the anterior superior spine and the lumbar region, where one can reach the abscess more easily and provide better drainage. Older abscesses should be incised where the fluctuation is most distinct. In one old case upon which I operated the abscess was on the left side, so that I made the opening above Poupart's ligament on this side.

Tumours of the Intestine.—The most important form of tumour of the intestine is the carcinoma. It does not occur here so frequently, however, as in the stomach. Carcinoma of the small intestine is the least frequent, that of the rectum and the large intestine the most so. The flexures of the colon are especially likely to be affected, particularly the sigmoid flexure. It is possible that the greater mechanical friction of the fæcal masses at these portions of the large intestine is of importance in connection with the development of carcinoma. Adenomata usually develop first sometimes in the form of polypous growths, which then gradually pass over into carcinomata. Of the

single forms of carcinoma, the carcinoma simplex and the scirrhus seem to be the most rare, while the colloid carcinoma is comparatively frequent. Carcinoma of the intestine usually presents, on gross examination, circumscribed, mostly soft nodules, or in other cases papillary growths extending over a large area. Cancerous infiltration of the adjacent parts of the intestine occurs rather early in connection with the circumscribed nodules as well as with the diffuse growths. This is sometimes extreme, so that the involved intestine becomes rigid and thick-walled for a considerable distance. There is almost always a pronounced destruction of the carcinomatous tissue, amounting, it may be, to complete perforation of the ulcer. The intestine is frequently adherent to the surrounding parts, and the retroperitoneal glands are often affected.

For a description of carcinoma of the rectum and the anus the reader is referred to § 179.

Other tumours of the intestine are rare in comparison with carcinoma. Fibromata and lipomata sometimes occur, and angeiomata, myomata, and sarcomata are still more uncommon. Primary sarcomata are sometimes found in the small intestine. Besides three of his own, Madelung collected eleven cases from literature. They are mostly round-celled sarcomata, and always develop in the submucous layer. The diseased part of the intestine is not constricted as in carcinoma, but dilated, in consequence of the early paralysis of the muscular coat. The pain is therefore slight, but, on the other hand, the rapid impairment of the general health is striking. In the majority of cases the disease does not last more than nine months (Madelung, Baltzer). Tumours of the connective-tissue type are sometimes observed also in the form of polyps, by which the passage of the intestinal contents may be more or less impeded. Complete occlusion of the intestine may also occur, when, for example, a fibrous or sarcomatous pedunculated tumour is dragged down by faecal masses, so that a complete invagination of the intestine occurs. By the rupture of the pedicle of a tumour and the evacuation of the latter *per rectum* a spontaneous cure may be effected.

Symptoms similar to those attending destructive neoplasms such as carcinomata may also be occasioned by gummata, tuberculosis, and actinomycosis. Tuberculosis of the intestine, which leads by contraction of the ulcers to stricture of the gut, is observed especially among young persons. It runs a chronic course, and is characterized by frequent attacks of colic (F. König).

Another form of tubercular disease of the intestine which should be distinguished from general tuberculosis of the intestinal tract is the

local tuberculosis of the ileo-cæcal region, a favourite place for the development of the disease. It is usually the result of direct infection by tubercle bacilli in the intestinal contents, and is characterized anatomically by thickening and induration of the wall of the intestine with the formation of ulcers. The disease frequently leads aside from stricture to perforation of the cæcum or the appendix, followed by peritonitis, fistulæ, etc. Clinically, tubercular disease of this region runs a course similar to recurrent appendicitis or a tumour.

Tumours of the intestine are often accessible to diagnosis only when they have reached a considerable size and interfere with the passage of fæces, or may be felt externally in consequence of their superficial location. Aside from tumours of the rectum, which are to be spoken of later in connection with diseases of the rectum, the new growths of the intestine are usually very movable tumours when they are not adherent to the abdominal wall. They may therefore be easily mistaken for a floating kidney, for example. The characteristic form of the kidney, however, is an indication of the latter. In malignant tumours, such as carcinoma and sarcoma, the rapidly increasing cachexia soon becomes prominent, as well as the symptoms of obstruction of the intestine. The differential diagnosis between a neoplasm and chronic inflammation of the cæcum is often very difficult.

The treatment of intestinal tumours, particularly carcinomata and sarcomata, consists in their earliest possible extirpation with corresponding resection of the intestine. Benign tumours should also receive this radical treatment as soon as they occasion serious obstruction of the intestine. Resection of the intestine is the more easily accomplished the more movable the involved part is—for example, the small intestine and the transverse colon. Resection of the cæcum, the ascending colon, and the descending colon, are the most difficult. Gangrene of the intestine at the last-named parts is also to be feared after resection in consequence of traction on the short mesentery (Billroth, König). In carcinoma and other diseases of the cæcum one may divide the ileum transversely, close the efferent end, and then either unite the afferent end perpendicularly to a slit in the colon, or close the afferent piece and suture it to the colon along a longitudinal incision in each (ileo-colostomy—Senn, Davies-Colley, and others). In all cases in which a diseased portion of the intestine can not be extirpated, lateral anastomosis above and below the diseased part comes into consideration (see § 169, page 126). One may also shut off the diseased portion completely from the rest of the intestine, and close both ends (see page 127). If serious obstruction already exists in connection with a tumour of the intestine, it is no doubt better to make

first an artificial anus above the stricture, because such patients do not generally survive the long duration of a resection of the intestine. The extirpation of the tumour may then be undertaken later, when the patient is in a better condition, and also the closure of the artificial anus. Another way is to extirpate the carcinoma immediately and then suture the two ends of the intestine into the wound and utilize them as an artificial anus, which can be healed later by detachment of the intestine and intestinal suture. Kœberlé resected successfully in this way a portion of the small intestine two metres long, which had become impassable in consequence of strictures, sutured the ends of the intestine into the abdominal wound, and then later did away with the artificial anus.

For the technique of intestinal suture and resection, see § 169, pages 121 and 124. For the formation of an artificial anus (enterostomy), see page 127 ff. For the treatment of carcinoma of the rectum, see §§ 179, 180.

§ 168. **Intestinal Obstruction.**—We have repeatedly alluded to intestinal obstruction—e. g., when treating of inflammatory processes in the peritoneal cavity, in connection with injuries of the diaphragm and the abdomen, foreign bodies and tumours of the gastro-intestinal canal, etc. We shall here take up the different forms of this condition connectedly, including, however, only those forms which may be designated as “internal strangulation,” as opposed to the strangulation or obstruction occurring in external hernia. The latter variety will be described under Hernia.

I. Congenital atresia of the intestine occurs most frequently at the rectum and anus. Regarding imperforate anus, with or without cloaca formation—that is, with or without an abnormal communication between the rectum and the bladder, the urethra or the vagina—the reader is referred to *Surgery of the Rectum* (§ 171).

Congenital stenosis or occlusion of the small intestine is much more rare than atresia ani, and that of the colon is rarer still. In the small intestine, complete or only partial membranous occlusion of the duodenum and of the ileum have been most frequently observed, also occlusion by volvulus in consequence of torsion of the umbilical cord. Congenital stenosis or occlusion may occur in the large intestine, particularly in the vicinity of the sigmoid flexure, as the result of volvulus following foetal inflammation of the mesentery.

II. Acquired stenosis or occlusion of the intestine is much more frequent than the congenital, and it is this that is of especial surgical interest. It arises from very varied pathological processes; especially from inflammations of the peritoneal cavity and the intestine and its

surroundings, from new growths, from a change in form and position of the intestine—e. g., from volvulus, from the invagination of an upper segment of the intestine into a lower one (intussusception), and finally in the course of external and internal herniae. Two main classes of intestinal obstruction may be distinguished: (1) Those forms which arise from contraction or occlusion of the lumen of the bowel from within, and (2) those produced from without by pressure or flexion.

A constriction or occlusion of the lumen of the gut from within is occasioned usually by cicatricial contractions and thickenings following the healing of intestinal ulcers, by tumours in the interior of the intestine, by foreign bodies, by intestinal concretions, by gallstones, by accumulated fæces, and also by intussusception.

Intussusception.—In intussusception an upper segment of the intestine is invaginated into a lower one, the reverse seldom occurring. The process may be compared to the infolding of the tip of a glove-

finger into the remaining part of the latter. The intussusception is usually single (Fig. 444, I), less often double (Fig. 444, II); that is, the upper segment of the intestine is invaginated once more into the portion below. Even triple invaginations are said to have occurred, so that seven intestinal walls lay one over another. In the ordinary single invagination there are three concentric cylinders of bowel (Fig.

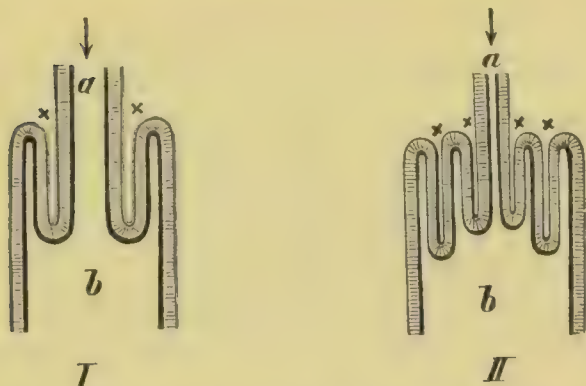


FIG. 444.—Intussusception (diagrammatic): I, single; II, double intussusception: *a*, the upper invaginated portion; *b*, the lower portion of the bowel.

444, I). The external cylinder is called, after Rokitansky, the sheath (*intussusciens*), the invaginated one the *intussusceptum*. The mesentery also is carried in with the invaginated portion, and in consequence of this the site of invagination is correspondingly distorted and kinked.

Intussusception occurs most frequently in the lower part of the ileum of children. One half of all intussusceptions occur, according to Leichtenstern, from the first to the tenth year, and about one quarter of the cases are observed in the first year. The cause of the invagination is not always apparent. It results most frequently from relaxation or paresis of a certain portion of the intestinal wall, in consequence of inflammation, so that, as a result of the peristalsis, the upper segment is pushed into the paretic portion. The length of the invagination is very variable. It is sometimes extensive, so that a large

portion of the small intestine is involved. As has been said, intussusception is observed most frequently in the lowest part of the small intestine, that of the ileum with the cæcum into the large intestine (ileo-cæcal intussusception) being very common. This ileo-cæcal intussusception is sometimes very extensive, so that the lowest part of the small intestine with the cæcum is pushed farther and farther on into the large intestine until it reaches the sigmoid flexure or even the rectum.

As a result of intussusception with compression of and traction upon the intestine and the mesentery, corresponding disturbances in the circulation of the intestinal wall and occlusion of the lumen occur which increase with the continuation of the invagination. The final result is variable. A cure sometimes ensues from spontaneous reduction of the invagination. In other cases a permanent stenosis of the intestine results from adhesion of the opposed serous surfaces (see Fig. 444, x). Or, again, a larger or smaller piece of the intestine may become gangrenous in consequence of circulatory disturbances. This gangrene either leads to perforation of the intestine with circumscribed or diffuse septic peritonitis, or no perforation occurs but adhesions are formed between the opposed serous surfaces of the upper and lower segments at xx, Fig. 444, and the gangrenous portion of the invaginated intestine sloughs away and is discharged *per rectum*.

The course of intussusception is sometimes very acute, and sometimes more chronic, lasting for weeks, months, or years. The acute course is most common, and many patients die from obstruction and perforation of the intestine with very acute symptoms. Leichtenstern, basing his calculation upon 557 cases, estimates the mortality of intussusception at seventy-three per cent. In view of this high death-rate, prompt operative interference is surely justified (H. Braun). Gangrene and elimination of the intussusceptum—that is, the attempt, as it were, of Nature to effect a cure—was observed, according to Leichtenstern, in 149 cases. Of these patients, forty-one per cent died. When recovery ensues, it is either complete, especially in case of reduction of the invagination, or there remain behind stenosis and adhesions of the intestine with corresponding disturbances, especially pain and fæcal accumulation. When intussusception takes a chronic course there is sometimes observed, in consequence of disturbances of nutrition and fæcal obstruction, an increasing marasmus, with fatty degeneration of the heart, the liver, and the kidneys, so that, as the result of this cachexia, one may suspect a malignant tumour of the intestine.

In another category of cases the intestinal obstruction is conditioned upon compression of the lumen of the intestine from without—

e. g., by a tumour of the ovary, uterus, spleen, liver, kidney, or pancreas, or by an abscess. Here belongs also the stenosis of the intestine resulting from a change in its form and position—e. g., from new growths, abscesses, etc.

In the course of apoplexy and diseases of the central nervous system in general, symptoms of intestinal obstruction are occasionally observed, resulting from the diminished or, at some part, wholly suspended peristalsis. Intestinal obstruction also occurs from embolism or thrombosis of the mesenteric artery and vein—e. g., after injuries, or from inflammatory processes in the branches of the portal vein, and it may be accompanied by gangrene of a corresponding part of the intestine (Frankenhauser, Adenot).

Volvulus, or torsion, of the intestine is an important cause of internal strangulation. In this condition a portion of the intestine forms a loop whose sides cross one another at the place of insertion of the mesentery. The intestine then becomes fixed in this abnormal position partly by other intestinal coils and partly by the weight of the distended portion of the intestine that is involved. It occurs most frequently at the lower part of the ileum and at the sigmoid flexure. The causes are external contusions of the intestine and the peristaltic movements of the intestine when it is unequally filled. Those persons are especially predisposed to volvulus, according to Küttner, who have an abnormally long and relaxed small intestine with an elongated mesentery. The intestine of the Russians, according to Küttner and Gruber, is, in consequence probably of their abundant vegetable diet, longer than that of most nationalities, and these authors explain in this way the comparatively great frequency of volvulus among the Russian population. All persons also with a dilated peritoneal cavity and relaxed abdominal wall, such as women who have frequently or recently borne children, are predisposed to volvulus. In consequence of twisting of the gut, circulatory disturbances naturally arise in the intestinal loop that is constricted, which may amount to gangrene and perforation of the intestine. The symptoms of intestinal obstruction, consisting of faecal vomiting and rapidly increasing collapse, appear very quickly in connection with volvulus. Death follows either from collapse caused by the obstruction, from paralysis of the heart and lungs, resulting from the extreme distention of the abdominal cavity, or from general septic peritonitis, due to gangrene and perforation of the intestine. Volvulus of the small intestine and the sigmoid flexure sometimes results, in case of a sufficiently long mesentery and mesocolon, in the formation of a knot. How does this knot arise? A loop is first formed by axial rotation—e. g., of the sigmoid flexure—and the neck or the fixed point

of this twisted loop is then surrounded by a coil of small intestine, especially of the ileum. Sometimes also a portion of the ileum lying above slips between the limbs of the original loop. In precisely the same

way, by a reversed process, the knot may be made by the sigmoid flexure after primary volvulus of the ileum. The former knot formations lie, corresponding to the location of the sigmoid flexure, in the region of the left sacro-iliac synchondrosis, the latter near the third or fourth lumbar vertebra. These two kinds of knot formation are, of course, not the only ones. Various other forms are possible, especially on the movable small intestine. Thus, for example, a long vermiform appendix or



FIG. 445.—Internal strangulation caused by an intestinal diverticulum which had wound itself about a loop of small intestine.



FIG. 446.—Strangulation of a loop of small intestine by a long ligamentous band.

a large diverticulum of the small intestine may entwine itself about the latter (Fig. 445, after Regnaud-Béclard). If a diverticulum does not end freely but is adherent to the abdominal wall, the mesentery, or the intestine, it may constitute thereby a further cause of internal strangulation. An intestinal loop may be ensnared by such a band and become flexed. Internal strangulation may arise in the same way from other bands (Fig. 446)—e. g., between the omentum or the intestine and the abdominal wall—from adhesions resulting from peritonitis, etc. König has pictured (Fig. 447) a very good example of the constriction of intestine by bands. We have already mentioned intestinal diverticula and the development of bands with or without a diverticulum (§ 154, pages 9 and 10), to which the reader is referred.

Intestinal obstruction may finally be caused by strangulation of the bowel in an aperture or pouch of the peritonæum and the mesentery. Among the normal openings or pouches of the peritonæum where strangulation may occur is to be mentioned first of all the cavity of the great omentum, between the liver, the stomach, the pancreas, and the spleen. This cavity communicates, as is well

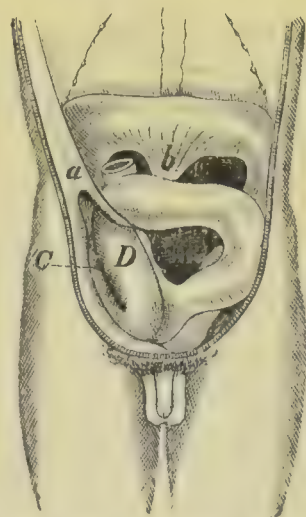


FIG. 447.—Internal strangulation caused by a band (*a b*) passing from the omentum to the anterior abdominal wall.

known, with the general peritoneal cavity through the foramen of Winslow between the hepato-duodenal and the duodeno-renal ligaments. The duodeno-jejunal fossa at the beginning of the mesentery of the small intestine may also become the site of an internal strangulation. This duodeno-jejunal fossa can receive the whole small intestine. The collection of intestinal loops in this fossa was first described by Treitz as a retroperitoneal hernia. Strangulation of the intestine has also been observed in the subcaecal fossa on the inner side of the caecum and in the intersigmoid fossa on the lower surface of the sigmoid flexure. Aside from all these normal pouches of the peritonæum, abnormal circular clefts, and apertures in the omentum, the mesentery and the mesocolon may also occasion internal strangulation. Klebs observed strangulation of the intestine in an abnormally narrow entrance to Douglas's sac. We have already mentioned (vol. ii, § 124, page 691) that strangulation of the intestine may take place in pouches of the diaphragm, and in congenital defects or acquired fissures of the same. We shall return to these diaphragmatic herniæ and the internal or retroperitoneal herniæ in § 194, under the subject of Hernia. We shall there take up in detail also the development of strangulated external herniæ. When treating of external herniæ we shall also become acquainted with a special form of internal strangulation, conditioned upon the reduction of a hernial sac *en masse*. In this condition reduction of the hernia is apparently effected, but the strangulation of the intestine persists (see §§ 183, 185).

For so-called pseudo-obstruction—e. g., after laparotomy—see page 47.

The symptoms of intestinal obstruction or strangulation vary with the cause. They either come on very suddenly, without any previous indications, or symptoms of digestive disturbances and obstruction to the passage of fæces exist for some time beforehand. If the occlusion of the intestine is complete, and the passage of fæces is entirely interrupted at the site of the strangulation, vomiting occurs, at first of the contents of the stomach and then of those of the intestine, accompanied by severe colicky pain resulting from the antiperistaltic movements. The contents of the duodenum and the jejunum, consisting largely of bile, are first evacuated. The vomited material takes on later more and more of a faecal character when the contents of the ileum are vomited. At the very outset there is more or less fever present, varying with the cause of the strangulation. The intestinal coils above the constricted part are correspondingly dilated in consequence of the retained fæces and gas, and the abdomen is therefore distended, and is extremely tender. The peristalsis is increased, the blood supply and the

secretion of the intestinal glands more abundant, and this accounts for the rapid accumulation of faecal contents of a thin, fluid character in the intestine. Reichel showed by experiments upon animals that resection of the intestine alone suffices for the formation of the often astounding quantities of faeces. The nourishment that is introduced, even when the patient has great thirst, contributes but very slightly to the formation of the faeces above the point of constriction. The secretion of the liver and the pancreas is probably increased also in connection with intestinal obstruction. The amount of urine is diminished, or the urine is totally suppressed. Death follows in part from rapidly increasing collapse, and especially from general septic peritonitis resulting from perforation of the intestine with the escape of faeces into the peritoneal cavity. Septic peritonitis may also arise without perforation of the intestine, because the microbes from the decomposed contents of the intestine or their toxins make their way through the intestinal wall to the peritonæum. Thus is explained why fatal systemic intoxication can follow from absorption of the toxins even when there is no general septic peritonitis. In favourable cases perforation of the intestine is followed by the formation of a circumscribed faecal abscess, as described in § 158, page 34 ff.

The course of intestinal obstruction varies greatly in its length. Death frequently ensues after one or two days, in consequence of rapidly increasing collapse or general septic peritonitis resulting from perforation of the intestine. Not infrequently a pronounced chronic course is observed, extending over weeks or months. I saw a volvulus of the sigmoid flexure in the case of a peasant who had had no passage from the bowels for six weeks. The abdomen was enormously distended, and the small intestines were enlarged to the size of a forearm. I made an artificial anus, but the patient died an hour later, from collapse.

The possibility of a cure from the spontaneous removal of the obstruction depends mainly upon the cause of the latter. The first therapeutic measures that are employed are of the greatest importance for a favourable course, as we shall see below, in connection with the treatment of intestinal obstruction. We have already mentioned (page 113) the possibility of a spontaneous cure by the elimination *per rectum* of the invaginated portion of the intestine in case of intussusception.

As regards the diagnosis of intestinal obstruction, the most important points are absolute stoppage of faeces and gas, also vomiting, particularly faecal vomiting, tympanites, and colicky pains. In every case of intestinal obstruction one should attempt to determine, first, at what part of the in-

testine is the obstruction? and, second, what is its cause? In order to answer the first question—regarding the location of the obstruction—stress must be laid upon the place at which the pain was first felt, the extent of the tympanites, fluctuation in the portion of intestine above the stenosis, and the character of the vomited material. For the timely recognition of strangulation, the local tympanites of the strangulated intestinal coil is of diagnostic importance (Wahl, Kader). If the strangulation is in the duodenum or the jejunum, the tympanites will be only partial, and the material vomited is merely bile-stained, not faecal. The lower down the strangulation is, the greater the tympanites and the more pronounced the faecal vomiting. The course of strangulation of the small intestine is, moreover, more acute than that of the large intestine, where complete occlusion does not develop so quickly as in the less voluminous and more movable small intestine. A careful examination *per rectum*, and in case of women *per vaginam*, is of importance in each case, as well as the introduction of bougies or the insufflation of air or gas—e. g., hydrogen gas—and the injection of water into the rectum by means of an irrigator. König found, in the case of a woman who was supposed to have died from an internal strangulation, a thin membranous stricture of the rectum which could easily be divided with the forefinger. The introduction of stomach tubes into the stomach and irrigation of the latter are also of value from a diagnostic standpoint.

The second question—as to the ætiology of the intestinal obstruction and its nature—frequently admits of no answer. Usually only conjectures are possible. In children intussusception is the most frequent cause. Strangulation by a diverticulum occurs most frequently in men from twenty to thirty years of age. Strangulation among women is caused particularly by bands and adhesions, resulting from previous peritonitis or from diseases of the ovaries or the uterus. If the first symptoms show themselves in the region of the vermiform appendix, the latter is probably the cause of the strangulation. An examination should always be made with reference to a possible simple faecal impaction, to the presence of gallstones, tumours of the pancreas, an external hernia, etc. The possibility of an obturator or ischiatic hernia should never be forgotten. A correct diagnosis as to the location and the character of an internal strangulation is most surely reached by prompt laparotomy.

The prognosis of intestinal strangulation is extremely unfavourable if the intestine is not very quickly liberated. Recoveries from spontaneous freeing of the strangulation are rare, in proportion to the great number of cases that terminate fatally. Death ensues most commonly from general peritonitis, with or without perforation of the intestine, from mechanical obstruction of the action of the heart and lungs in consequence of extreme tympanites, etc. It is a favourable outcome if, after perforation of the intestine, a circumscribed, encapsulated faecal abscess develops and a faecal fistula is formed. Through early laparotomy the prognosis of intestinal obstruction will be more favourable in the future. It is to be regretted that at the outset of the disease neither physician nor patient can decide to have laparotomy performed, this being looked upon, unfortunately, as a last resort. The decision of the question really lies in the hands of the medical attendant. If patients with intestinal strangulation are sent to a surgeon for operation early enough,

more recoveries will certainly be seen in the future than has been the case heretofore.

Treatment of Intestinal Obstruction or Strangulation.—Cathartics should be avoided at the outset, as the peristalsis is increased thereby and the strangulation made worse. The chief remedy is opium, given in large doses by mouth or rectum. Wine and broken ice are also given internally, and warm applications are made to the abdomen. Cold applications are usually not well borne. Severe pain is relieved by hypodermic injections of morphine. Cathartics are only given when the obstruction is conditioned upon faecal accumulation. One should also, in such cases, inject large amounts of water into the rectum and the colon. Hard masses of faeces and faecal concretions are sometimes found in the rectum which require in some cases to be broken up and removed by the introduction of the hand or forceps.

The attempt should also be made to act upon the obstruction itself by washing out the stomach, which was first employed in this connection by Kussmaul, and by the injection of water or the insufflation of air into the intestine through the rectum. For the technique of washing out the stomach the reader is referred to page 84. Water is injected into the intestine through the rectum by means of an irrigator, after a rubber tube has been introduced as high up as possible. The pelvis should be elevated as much as possible. A favourable effect is sometimes seen at once after irrigation of the stomach and injection of water, or insufflation of air into the intestine through the rectum—e. g., by means of a rubber tube with a double bellows of India rubber attached. For the tympanitic distention of the intestine, its puncture with the needle of an aspirating syringe has recently come into use again. As has already been said, this procedure is not without danger. All the remedies which have been mentioned thus far have really only a palliative effect, as they are not directed against the condition itself, with the exception, perhaps, of lavage of the stomach, the effect of which is always very uncertain, and the distention of the intestine with water or air. This palliative treatment of the obstruction has the very bad result that the physician allows himself to be deceived by the comparatively good condition of the patient, and so the proper time for operating is often allowed to pass by unimproved. A radical treatment of intestinal strangulation is only possible by an operation which consists in finding the obstruction and relieving it. The earlier laparotomy is performed, while the tympanites is still slight and the patient is in good condition, the more favourable is the result. In the later stages, when the tympanites is extreme and the patient has become weakened, the result of the operation is usu-

ally unfavourable, and one often does not find the obstruction at all, in consequence of the distention of the intestines. We have already pointed out that at the beginning neither physician nor patient is likely to give his consent to the operation; nor is there unanimity among surgeons as to which is better—an operation, or treatment with opium. Laparotomy is in such cases always a dangerous operation, and a favourable termination can never be assured. If radical treatment for overcoming the obstruction is no longer possible, one may at least relieve the sufferings of the patient by making a fæcal fistula or an artificial anus, and then await further events.

If laparotomy is decided upon, the stomach should be washed out beforehand, and the surgeon should try to find out as exactly as possible in each case the location and probable character of the obstruction. The peritoneal cavity is opened by an incision from the ensiform cartilage, it may be, as far as the symphysis. If it is desired merely to draw out an intestinal loop for the formation of a fæcal fistula, a small incision at the proper place is sufficient. In the former case the strangulated part of the intestine is searched for by palpation, beginning at the stomach. In looking for the point of obstruction, one must also examine the region behind the stomach and the pancreas, the vermiform appendix, the above-mentioned peritoneal pouches, possible apertures in the diaphragm, in the mesentery, the mesocolon, etc. In case complete evisceration proves necessary, the intestines must be enveloped in warm, moist, aseptic compresses. After the obstruction has been found, an effort, suited to its cause, will be made to overcome it—e. g., bands will be severed, a volvulus or intussusception carefully reduced, etc. After the obstruction has been relieved, the intestines are, if healthy, disinfected and put back into the peritoneal cavity, their contents being first pushed forward in the direction of the rectum. If the intestines are too much distended, so that their reposition is attended with difficulty, they should be emptied as completely as possible by incision, and then replaced after closing the incision with Lembert sutures (see page 121). If the intestine is gangrenous at the point of obstruction, the part thus affected should either be resected, or, better, the gangrenous loop of intestine should be sutured into the external abdominal wound and an artificial anus made (see page 127), which is closed later by detachment of the intestine from the abdominal wound, resection, and suture. Each case will be treated in accordance with the nature of the intestinal occlusion. If the latter can not be overcome, the question may finally arise of making a lateral anastomosis above and below the stricture (see page 126).

In the later stages of intestinal strangulation, when the intestine is very much distended in consequence of tympanites, it is often difficult or impossible to find the site of the obstruction. One should at least, in such cases, relieve the distress of the patient by opening a distended intestinal loop above the obstruction and making a fæcal fistula or an artificial anus. After the peritoneal cavity has been opened by a small incision an inflated intestinal loop is sutured into the abdominal wound and a small opening made in it. Such fæcal fistulæ may heal later spontaneously, in case the patient lives, or may be closed by an operation. In case the obstruction is situated low down—e. g., in the upper part of the rectum—the formation of an artificial anus in the sigmoid flexure is necessary (see page 129). The formation of a fæcal fistula or an artificial anus is indicated as a palliative operation when the condition of the patient is such that he can probably not withstand a more prolonged laparotomy, also when the obstruction is due to an inoperable carcinomatous stricture, or when the obstruction is not found at all. If peritonitis already exists, laparotomy is still indicated as long as there is any hope of saving the patient. In case of a circumscribed fæcal abscess this should be incised and drained. The reader is referred to the following paragraphs for a description of the operations on the intestine already spoken of—viz., enterotomy, enterorrhaphy, enterostomy, resection of the intestine, and the operative closure of an artificial anus and fæcal fistula.

§ 169. **Indications for and Technique of Operations upon the Intestine** (the rectum and the anus excepted).—Enterotomy, or simple incision of the intestine, is performed chiefly for the removal of foreign bodies which have become impacted at some point and can not be discharged *per rectum*. The opening in the intestine is made with a knife and always in a longitudinal direction, as far as possible from the insertion of the mesentery—that is, opposite the latter, on the free border of the gut.

Intestinal suture (enterorrhaphy) is performed in case of wounds of the intestine that have resulted from accident or have been made by the surgeon. In introducing the sutures the involved part of the intestine is drawn as far as possible out of the peritoneal cavity and placed upon a moist, warm compress of gauze, so that the peritoneal cavity is protected by the latter from pollution and infection. The intestine is shut off provisionally by compression with the fingers, special instruments (see page 94), or simply by tying two silk ligatures about the bowel. The closure of simple incised wounds, whether longitudinal or transverse, is accomplished by Lembert's method of suture, which consists in bringing together the outer serous surfaces

of the intestine, while the edges of the wound are infolded. Enterorrhaphy is performed with very small needles and the finest aseptic silk or catgut. The needle is inserted superficially into the intestinal wall,

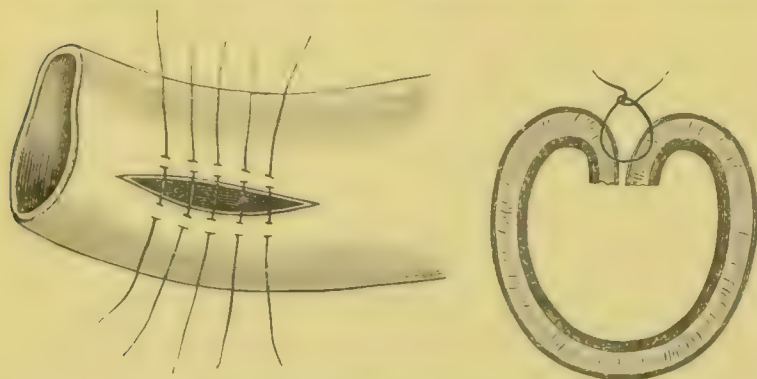


FIG. 448.—Lembert's suture.

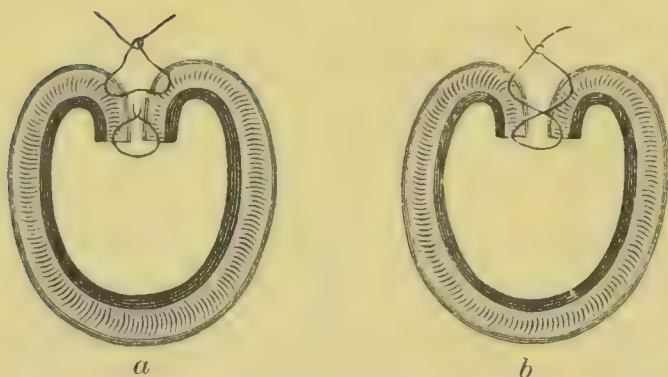


FIG. 449.—Double row of intestinal sutures, after Czerny (*a*), and figure-of-eight suture, after Gussenbauer (*b*).

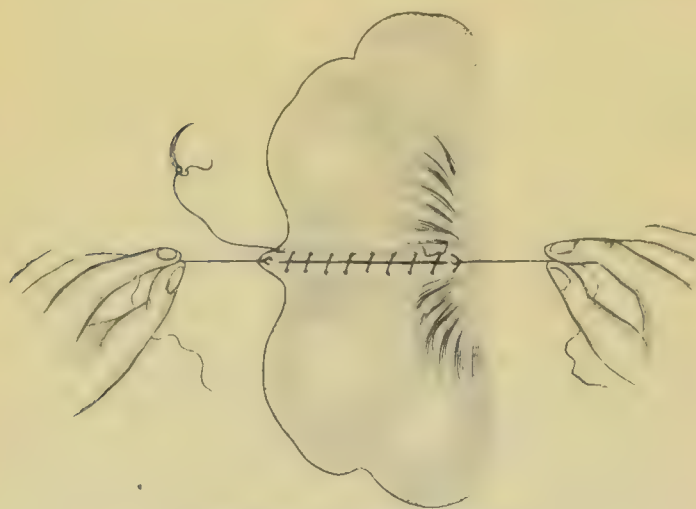


FIG. 450.—Continuous suture.

by means of the latter the intestine is lifted up and the edges of the wound thus brought into apposition (Fig. 450). The infolded edges are now united by a continuous catgut suture, which includes the serous and the muscular coats, and over this a second continuous suture of the same material taking in only the serous coat (Fig. 450).

carried for from a third to half a centimetre through the serous and muscular coats without entering the mucous membrane, and brought out again near the margin of the wound. The same process is repeated on the other side of the wound. The individual sutures, which are inserted as near one another as possible, are then tied (Fig. 448) and the ends cut off short. Over this first row of stitches a second row of interrupted sutures is applied (Fig. 449, *a*). Gussenbauer recommended a figure-of-eight suture (449, *b*). I always employ instead of the interrupted sutures a continuous suture with very fine silk or catgut and in two rows. An interrupted suture of fine silk is first inserted at each of the two ends of the wound. The silk sutures are left long, and

The continuous suture (see Principles of Surgery, p. 107, Fig. 89) requires much less time, and brings the serous surfaces into better apposition than interrupted sutures. For intestinal sutures I prefer, generally speaking, very fine silk to catgut, as the latter, in spite of every precaution, is sometimes not so sterile as silk, and the latter can be had in smaller sizes.

Circular enterorrhaphy demands a special technique. It is used after a complete division in continuity of the intestine where its two ends must be brought together. The temporary closure of the intestinal lumina while sutures are being inserted is accomplished either by compression with the fingers of an assistant, or by a loosely applied ligature of silk, or by the clamps mentioned in connection with gastrorrhaphy (see Fig. 437, page 94).

Circular enterorrhaphy can also be executed precisely like linear enterorrhaphy, and it is best to insert a double row of sutures. One should, however, take care in circular enterorrhaphy not to bring the serous surfaces into too broad contact, as there may easily arise in this way an annular inward projection of the mucous membrane which diminishes materially the lumen of the gut. As in suture of the stomach and duodenum after pylorotomy, so in circular enterorrhaphy one should insert the first sutures from within the intestine in the posterior wall of the gut, and they should include the muscular and serous coats. The edges of the mucous membrane, through which the sutures do not pass, come together of themselves. Circular enterorrhaphy should always begin with this inner suture of the posterior wall, and I always suture from within as long as possible. The second row of sutures is then applied from the outside. Or the method shown in Fig. 450 may be employed—that is, a silk suture is passed through the two ends of the intestine near the mesentery, the intestine is lifted up by means of the ends of the silk that are left long, and then the infolded edges of the intestinal wound are united by a continuous suture that takes in the serous and muscular coats. A second continuous suture is added above this, which includes only the serous coat.

In all cases in which the ends of the intestine can not be united by circular enterorrhaphy, both ends may be closed by suture and then a lateral anastomosis made (see page 126).

Invagination of the upper segment of the intestine into the lower one, which was used a good deal at one time, has now been abandoned. In order that the serous surfaces may be as broadly contiguous as possible, Jobert recommended that the end of the lower segment be infolded and the upper end be then pushed into the lower end and secured by suture.

In order to facilitate the performance of enterorrhaphy, to protect the line

of suture from contact with the contents of the intestine, and to secure the free passage of the faeces, Neuber introduced into the intestine a tube of decalcified bone with a diameter of two or three centimetres (Fig. 451). The intestine is pressed into a circular groove on the tube by a purse-string suture,

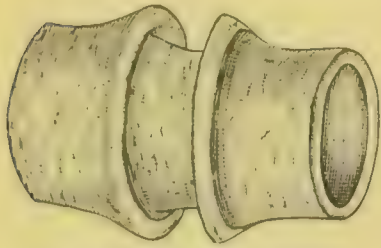


FIG. 451.—Neuber's tube of decalcified bone.

and the tube is thus held in place. Or one may substitute for the first row of stitches the application of a firm ligature about the ends of the intestine over the tube. The serous surfaces of the intestine are then brought by invagination into broad and close contact, and sutures are inserted. The tube is absorbed for the most part, and what remains passes off with the faeces. Jobert, Denans, and others introduced in like manner a metallic ring into one or both ends of the intestine,

turned in the edge of the bowel over it, and then invaginated the two ends. Senn has employed an India-rubber ring and, more recently, two decalcified bone plates (see page 126, Fig. 453, *a*). He also recommended that the line of suture be protected and its union hastened by covering it with peritonæum or a small piece of omentum.

Murphy's button is a very useful device (Fig. 452). The two portions of the nickeled button *a* and *b* are fastened into each end of the intestine by a purse-string suture and then pressed together. For greater security the two ends of the intestine may be further united by sutures through the serous coat. When the button is used for end-to-end union of intestine, the purse-string suture passes around each side to and from the attachment of the mesentery, and special care is taken to close the triangular interval which exists here by means of the return stitch. The button is usually passed *per rectum* in from

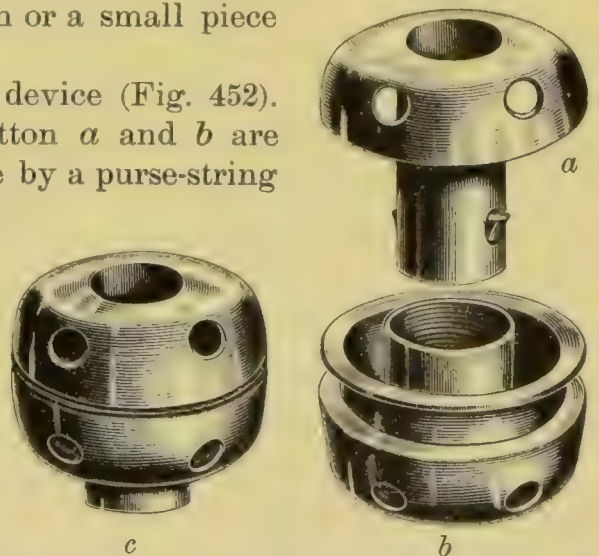


FIG. 452.—Murphy's button: *a* and *b*, the two halves of the button; *c*, after union of the two halves.

one to two weeks. In some cases marked contraction of the opening occurs soon after the insertion of the button, and in one case the button lay above the stenosis. Murphy's button can also be used in gastroenterostomy, lateral anastomosis, and cholecystenterostomy, and allows a much quicker performance of the operation than the usual methods of suture.

Resection of the Intestine is indicated especially for malignant new growths (carcinoma, sarcoma), strictures, wounds, gangrene of the intestine, in the closure of an artificial anus, and in case of prolapse of an invaginated colon through the rectum. The operation should always be performed outside the peritoneal cavity as far as possible, and the intestine must therefore be made sufficiently movable and drawn out through the abdominal incision. It is then placed upon a moist, warm

gauze compress, so that the peritoneal cavity is protected by the latter from all pollution. Prolapse of the intestines and too great cooling off of the peritoneal cavity are also thereby prevented. If the laparotomy wound is large it may be partially closed by temporary sutures. After the contents of the intestine have been stroked away from the part that is to be resected, the afferent and efferent ends of the intestine are closed by an assistant by pressure with the fingers, or, better, by means of a circular silk loop passed through the mesentery, or by special instruments (see page 94, Fig. 437). Before the intestine is resected the mesentery is detached transversely. The amount of detachment depends upon the length of the portion to be resected; it should not be separated from the stumps of the intestine, as gangrene of the line of suture and fatal perforation may ensue. Transverse detachment of the mesentery is to be preferred, in my opinion, to the excision of a V-shaped piece; the vessels should be tied separately, and not by ligatures *en masse*. After detachment of the mesentery, and after the hæmorrhage has been arrested by tying the vessels separately, the part of the intestine in question is excised with scissors. The two ends are then united by means of two rows of a continuous suture with fine silk, as described on page 123. If the ends of the intestine are not of equal diameter, one may enlarge the smaller lumen by cutting off the end obliquely (Wehr). In case of considerable difference in the diameters of the intestine, a wedged-shaped piece may be cut from the end of the large intestine (Rydygier). The edges of the divided mesentery are also united by a continuous suture of fine silk.

In place of circular enterorrhaphy, the two ends of the intestine may be closed by two or three rows of sutures, the two portions laid side by side longitudinally, and an anastomosis established as described on page 126. Bloch recommends, in case of carcinoma, for example, extra-abdominal resection of the intestine—that is, the diseased portion is first fixed in the abdominal wound, which is bordered with peritonæum and an artificial anus is made. The diseased part is resected later, the ends united by circular enterorrhaphy, and the intestine returned to the abdominal cavity.

The mortality of resection of the intestine averages, according to B. Rosenthal, 42·3 per cent.

It is important to consider how much intestine can be removed without harm. The successful cases of Hahn, Kocher, Kœberlé, and Schlange show that pieces of small intestine of much more than a metre in length can be resected without permanent damage. The experimental investigations of Trzebicky demonstrate that it is possible to resect without harm as much as 280 centimetres from the jejunum and ileum with preservation of the duodenum—i. e., half of the small intestine. Resection of two thirds and more of the small intestine is always fatal. Resection of the upper part of the jejunum is harder to withstand than that of the lower part of the ileum.

Lateral Anastomosis.—By lateral anastomosis, which was first employed by Maisonneuve and Hacken (1863), is understood the formation of an artificial connection between a portion of the intestine above and one below the constricted point. The intestine is opened by a longitudinal incision above and below the stenosis, and the two openings are then united by Lembert sutures. Here also Braun's method of suture is strongly to be recommended. The two portions of intestine are united by a few sutures, and an incision is made, two or three millimetres from the line of suture, through the serous and muscular coats down to the loose tissue of the submucous layer, so as to determine exactly how deep the needle can be inserted in order to include the serous and muscular coats, and, on the other hand, to avoid the mucous membrane. The latter is not divided until the sutures have been inserted. Senn recommends the use of decalcified bone plates as follows: A longitudinal incision is made in the intestine above and below the stenosis and a decalcified bone plate, six or seven centimetres long and two and a half centimetres broad, with a central perforation and carrying four loops of fine silk (Fig. 453, *a*), is fitted into each lumen. The two threads on the longitudinal sides of the plates are provided with small round needles, which are passed from within through the muscular and

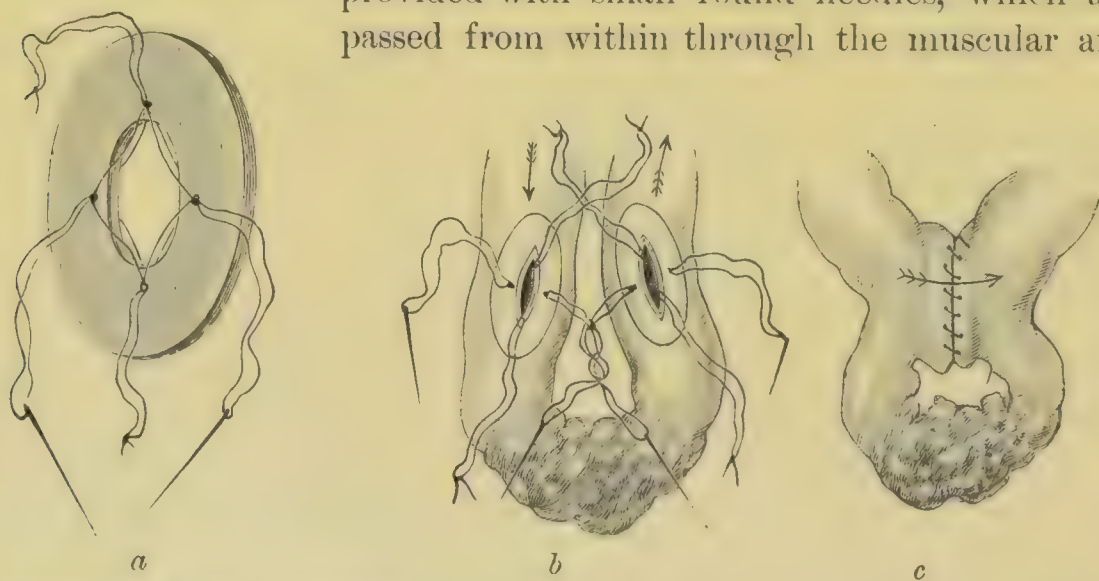


FIG. 453.—Senn's method of performing lateral anastomosis: *a*, plate of decalcified bone; *b*, plates in position within the intestine; *c*, after completion of the operation.

serous coats of the margins of the visceral wounds (Fig. 453, *b*), and the four corresponding pairs of threads are thereupon tied. The serous surfaces of the two portions of intestine are in this way brought intimately in contact. It is a good plan to unite the serous surfaces still further by a continuous suture with fine silk (Fig. 453, *c*). The bone plates are very soon absorbed. Baracz uses in the same way a portion of a turnip which is cut into the proper shape. Senn's method,

which requires a very short time, does not seem to me sufficiently secure for use on man. Senn obtained good results, but others have not had favourable experience with it (Abbe, Reichel, Weir, and others). The methods proposed by Senn, Lennep, Brackau, and Abbe are most excellent for the thicker intestines of dogs, but for man a simple enterorrhaphy is, in my opinion, the best, though, to be sure, as compared with Senn's plates, it has the disadvantage that it requires more time. Halsted, after excision of the diseased portion, closes the ends of the intestine, lays them alongside one another longitudinally, opens them, and unites the two slits by suture.

In cases where the diseased portion of intestine can not be excised Salzer recommends separating this portion from the rest of the bowel, closing both ends, and then uniting the other two ends by circular enterorrhaphy (Fig. 454). Salzer afterward recommended making a fistula in the distal end of the separated portion for the purpose of permitting local treatment of its inner surface. Recent experience has shown, however, that this is not necessary and that there is no danger of its rupture in consequence of continued secretion of mucus (Baracz, Obalenski, and others).

As in gastro-enterostomy, the occurrence of a contraction of the anastomotic opening in lateral anastomosis should be prevented by suitable measures (see page 96, Gastro-enterostomy; for a description of ileo-colostomy, see page 110).

Entero-coloplasty.—Crespi, Micheli, and De Sanctis have successfully grafted in dogs twelve to fifteen centimetres of the small intestine into the continuity of the large intestine, after corresponding resection of the latter.

Enterostomy, or the formation of an artificial anus, is performed usually for intestinal obstruction—e. g., in cases of strangulation, new growths, strictures, imperforate anus, carcinoma of the rectum, vesico-intestinal fistulæ, etc., in order to provide temporarily or permanently a means of escape for the contents of the intestine. Sometimes the small intestine and sometimes the large intestine is opened, according to the location of the stenosis. In order to avoid interference with the

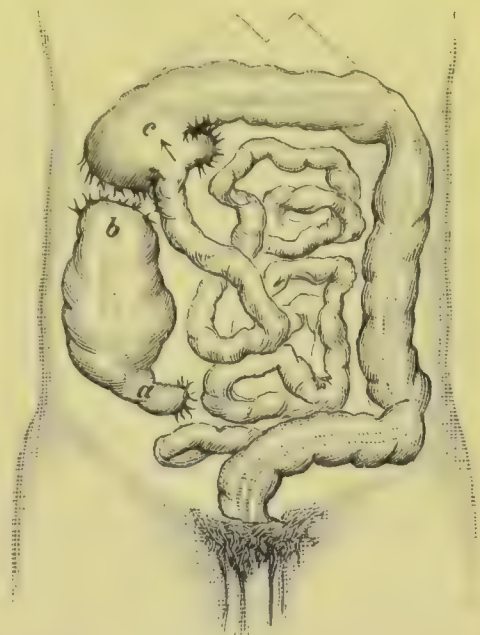


FIG. 454. — Intestinal anastomosis in which a portion of the bowel (*a b*) is completely separated from the rest and closed at both ends; the small intestine is sutured into the side of the transverse colon at *c*.

nourishment of the patient, the opening in the intestine is made at a point as low down as possible—that is, if practicable, in the descending colon, or, better, in the sigmoid flexure, less frequently the cæcum. Enterostomy of the large intestine is also called colostomy. It is performed usually for inoperable carcinomata or malformations of the rectum (imperforate anus). In case of an obstruction that has a very high location in the small intestine, enterostomy is performed in order to save a patient from certain death, or at least to relieve his suffering. If the patient lives, a radical operation can be performed later when the conditions are more favourable. Since the introduction of asepsis, we have not the same fear as the older surgeons had of opening the peritoneal cavity, and we therefore perform colostomy, not extraperitoneally but intraperitoneally. Intraperitoneal colostomy, to which the preference is given, generally speaking, upon the Continent, though this is less the case in England, was first proposed by Littré in 1710, and performed for the first time by Pillore in 1776.

The mortality of colostomy was, according to Nussbaum's tabulation of 262 cases, forty-two per cent. Since the adoption of antiseptic methods this death-rate has been considerably lowered.

1. **Colostomy on the Descending Colon** is performed preferably in the iliac region, inasmuch as the lumbar method is often impracticable or dangerous on account of the variable relations of the peritonæum on the posterior surface of the colon.

The patient lies upon his back or on the right side, and the iliac region is slightly elevated by means of a roller cushion pushed beneath, in order to increase as far as possible the space between the free border of the ribs and the crest of the pelvis. The skin incision is made in a vertical direction from the tip of the eleventh rib to the crest of the ilium. After division of the abdominal wall by layers (skin, superficial fascia, muscles, transversalis fascia), ligation of the lumbar arteries, and incision of the parietal peritonæum, the latter is attached to the skin by continuous catgut sutures. The descending colon, which is well characterized by its three smooth, longitudinal bands, is then drawn out of the wound and fixed by an India-rubber tube, strip of iodoform gauze, or hard India-rubber pin passed through the mesocolon (see Fig. 455, page 130), and by a few Lembert sutures. The stitches include only the serous and muscular coats of the intestine, but take in the entire thickness of the abdominal wall. After the intestine has been fixed in the abdominal wound, it is either opened immediately, or, if possible, from one to three days later, after it has become thoroughly adherent. Adhesions are usually present after twenty-four hours or even less. It generally has to be opened immediately. The method

employed by Braun is also useful. After attaching the intestine to the peritonæum with very fine silk sutures he makes an incision in the former down to the submucous layer, unites the edges (serous and muscular coats) of this incision with the abdominal wall, and finally the mucous membrane is incised. The intestine should be attached and opened near the mesenteric insertion. A sort of spur formation is secured in this way, and the direct escape of the fæces is facilitated. The circular fibres of the upper segment of the intestine form later a sort of sphincter, so that solid fæcal matter is held back (Kappeler, Allingham).

In opening the intestine, special care must be taken to protect the line of suture from contact with the contents of the bowel by sprinkling it with iodoform and laying sterilized gauze about it, etc. The intestine is opened by puncture with a knife, and a long India-rubber tube is pushed into its afferent end. The opening may also be made, if desirable, with a small trocar, whose canula is left in position. After partial evacuation of the intestine, the opening is enlarged and the mucous membrane stitched to the sides of the abdominal wound.

In case of inoperable carcinoma of the rectum, the colon may be completely divided, the proximal end of the intestine sutured to the abdominal wound, forming an artificial anus, and the distal end closed by a double row of sutures and dropped back into the peritoneal cavity (Schinzinger, Madelung, the author). The painful irritation of the carcinoma by the fæces is thus prevented.

2. **Lumbar Colostomy**, after Callisen and Amussat, of which we have already spoken as not strongly to be recommended, is performed as follows: The patient lies upon the right side with a roller cushion pushed under the lumbar region. The transverse skin incision runs parallel to the crest of the ilium about two fingers' breadths above it or midway between the latter and the eleventh rib. It begins at the outer border of the sacro-lumbalis muscle. The separate layers are divided and the edge of the quadratus lumborum incised. The fatty cellular tissue is finally reached, and after this has been divided by blunt dissection the posterior surface of the colon appears. The latter is drawn forward as far as possible into the wound by means of two silk sutures, opened with a trocar, and, after it has been partially emptied, the puncture opening is enlarged with a knife and the edges of the intestine are sutured to the skin.

3. **Inguinal Colostomy on the Sigmoid Flexure**.—This is the form of colostomy most in use, and was first performed by Littré. The skin incision is seven or eight centimetres long and runs a thumb's breadth above and parallel to Poupart's ligament. It begins on a level with the anterior superior spine of the ilium. After division of the skin, the superficial fascia, the muscles and the transversalis fascia by layers,

and arrest of the hæmorrhage, the peritonæum is seized with forceps, opened, and united with the edges of the skin by a continuous cat-gut suture. The protruding loops of small intestine are pushed back and the sigmoid flexure sought out, which is recognised by its longitudinal bands. The sigmoid flexure is then fixed in the abdominal wound by an India-rubber tube, a strip of iodoform gauze or a hard India-rubber pin (see Fig. 455) passed through the mesocolon, and by a few Lembert stitches, and opened at once, or, better, one to three days later, if one can wait (see particulars concerning the technique of the operation, page 128). A tongue-shaped flap, consisting of skin, subcutaneous tissue, fat, and external oblique fascia, and draws it through a slit in the mesocolon, so that it furnishes a support for the intestinal loop. The intestine is, if possible, not opened until this flap has united.

4. Colostomy on the cæcum may become necessary in case of an obstruction that is situated higher up in the large intestine. The method is the same as that which has just been described for inguinal colostomy on the sigmoid flexure. The skin incision is at the same place on the right side.

5. Enterostomy on the small intestine is performed for strictures or occlusions located in the small intestine itself. The technique is the same as that of colostomy (see page 128). The cases are almost always very urgent ones, death being threatened from intestinal obstruction. The place at which the peritoneal cavity is opened depends in part upon the nature of the case. The incision is usually made in the linea alba or in the right or left iliac region. The lower part of the ileum is found by the right iliac incision given for opening the cæcum. One of the most distended loops of the small intestine is

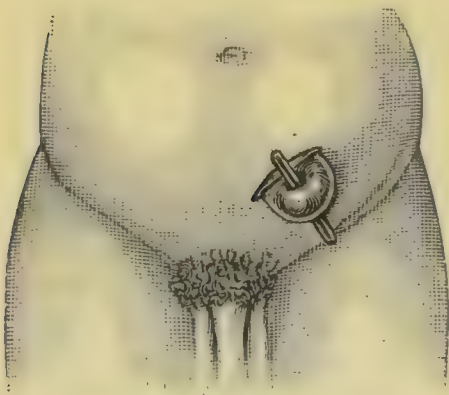


FIG. 455.—Inguinal colostomy.

selected to be sutured into the abdominal wound, which is bordered with peritonæum. After this loop has been secured in the abdominal wound by pushing an India-rubber tube beneath it (see Fig. 455) and by means of a few Lembert sutures, special care must be taken in opening it that no fæces enter the peritoneal cavity. A puncture opening is therefore made at first, and an India-rubber tube is then pushed into the intestine, or, if desired, a trocar may be used, and its canula left in place. The puncture opening is enlarged later and an India-rubber tube inserted.

Different procedures have been devised of late to render an artificial anus self-closing. Gersung employed torsion of the intestine (see pages 000, and 000). Witzel drew the intestine through the left rectus muscle and sutured the efferent end in the lower and the afferent end in the upper angle of the longitudinal wound; the muscle acts like a sphincter. The intestine can be given an oblique course by carrying it for some distance beneath a long cutaneous bridge, or, better, through muscle as well, such as the left rectus, or through a trephine hole in the ilium (see also page 176). If, furthermore, the efferent end is closed and the afferent end allowed to protrude from the abdominal wound like a penis, it can easily be closed by pressure with a pad (Lauenstein). Witzel's gluteal colostomy also permits firm closure of the artificial anus by pressure against the bone. He makes an incision along the left crest of the ilium and carries the sigmoid flexure beneath the skin into the upper lateral gluteal region.

The best mechanical device for closing an artificial anus is a double India-rubber bulb having the form of an hour-glass. One bulb lies in the intestine and the other externally upon the abdominal wall. They are then both inflated by means of an external India-rubber tube, and thus close the artificial anus hermetically.

6. Lateral Anastomosis.—Obstruction arising, for example, from an inoperable carcinoma may also be overcome by connecting the parts of the intestine above and below the stenosis and thus excluding the part that is impassable. This procedure may be compared to gastro-enterostomy for stenosis of the pylorus from an inoperable carcinoma, and both operations are done in essentially the same way. Lateral anastomosis has already been described on pages 126 and 127. For ileo-colostomy see page 110.

Operative Closure of an Artificial Anus.—If the condition for which the artificial anus was made has been remedied, either spontaneously or by an operation, and the intestine has again become passable, an attempt will be made to close the artificial anus, in order that the fæces may be evacuated in the normal way. This procedure is most frequently undertaken upon patients who have had a strangulated hernia (see Hernia). The chief obstacle to the spontaneous healing of an artificial anus is the so-called spur—that is, the projection between the afferent and efferent lumina. This spur is most pronounced when the abnormal anus has arisen from sloughing of an entire intestinal loop. The abnormal anus then consists of a double lumen, and between the two orifices the so-called spur projects, which is formed by the two adherent walls of both limbs, together with the mesentery (Fig. 456, after Albert). If there has been only a partial enterocele—that is, if only the anterior wall of the intestine has become gangrenous—or if the abnormal anus is the result of an injury or an operation, the spur is at first absent (Fig. 457, after Albert). It may, however, develop here

also, in consequence of increasing prolapse of the posterior intestinal wall. There are numerous intermediate forms between the two extremes represented in Figs. 456 and 457.



FIG. 456.—Artificial anus with spur following gangrene of a strangulated knuckle of intestine. The afferent and efferent portions of the bowel are partially opened.

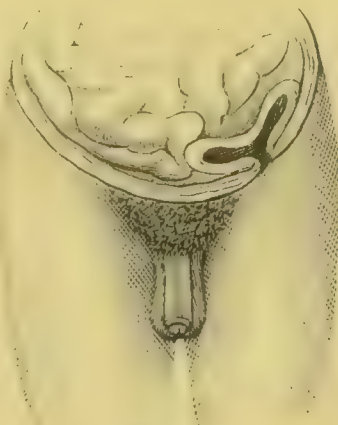


FIG. 457.—Artificial anus without a spur. The intestine is partially opened in the vicinity of the artificial anus.

Before the adoption of antiseptic methods, the prolapse of the posterior wall or the spur was forced back mechanically in various ways or destroyed by compression. The prolapsed posterior wall can be forced back by the introduction of a crutch-shaped

instrument recommended by Dupuytren, or a thick India-rubber tube, or by the use of India-rubber bulbs that can be inflated (Maurer). In

case, however, of extreme spur formation in consequence of the adhesion of both intestinal walls, as in

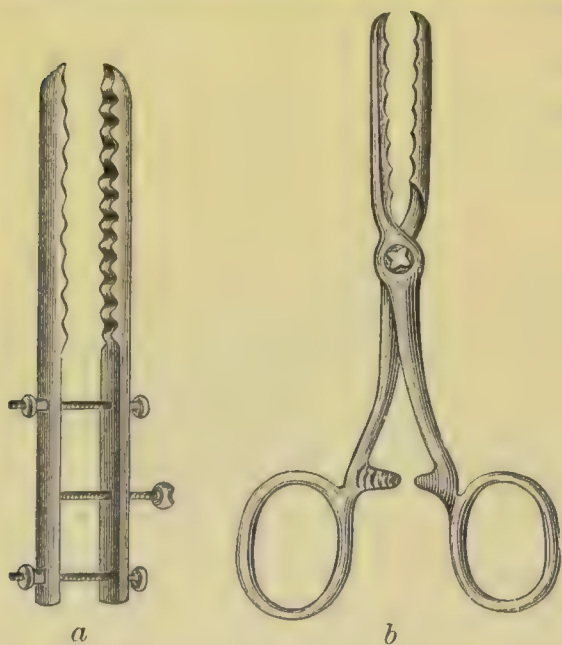


FIG. 458.—Enterotomes: *a*, Dupuytren's; *b*, Collin's, which is used for destroying the spur in an artificial anus.

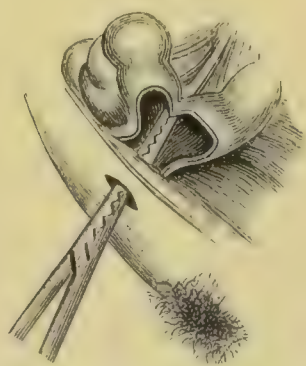


FIG. 459.—Destruction of the spur by means of an enterotome. The anterior wall of the intestine is cut away in the vicinity of the artificial anus in order to show better the position of the enterotome.

Fig. 456, the spur may be destroyed (Fig. 459) by the use of Dupuytren's enterotome (Fig. 458, *a*), or, better, Collin's (Fig. 458, *b*). The clamp is allowed to lie for from eight to twelve days, and it then falls off of itself after necrosis of the spur. The clamp must, of course, be so applied that the peritoneal cavity is not opened, nor any intestinal loops that may lie in the angle behind the spur seized by the instrument.

The operative closure of an artificial anus consists in resecting the part of the intestine in question with subsequent enterorrhaphy. The abdominal wall is divided, the afferent and efferent limbs detached near the artificial anus, the intestine drawn out of the peritoneal cavity, and, after resection of the part in question, the two ends are united by a double row of circular sutures, as already described more in detail on pages 124 and 125 (Technique of Intestinal Resection) and on pages 121–124 (Enterorrhaphy). The efferent end of the intestine is sometimes so contracted at its beginning that it is necessary to remove a large piece of it. Mild degrees of stenosis can be overcome before the operation by the introduction of bougies, by India-rubber bulbs that can be inflated, etc. The intestine is thoroughly disinfected and dropped back into the peritoneal cavity, and the abdominal wound closed after freshening its edges. In case of stricture or closure of the afferent end, lateral anastomosis may become necessary. In some cases an artificial anus may be closed *in situ* by partially freeing it without opening the peritoneal cavity.

The above-mentioned treatment of an artificial anus with clamps is not employed as much at present, but I should consider it wrong to abandon it altogether. It is, at any rate, less dangerous than resection of the intestine, and it should be performed whenever it is practicable. The mortality attending it is, according to Körte, 9·9 per cent, while that of secondary resection and enterorrhaphy is 27 per cent.

Fæcal fistulæ are more or less narrow canals which communicate with the intestine and discharge fæces. Very small fistulæ may be closed by galvano-caustic ustion, cauterization, etc. So-called labiform fistulæ, in which the mucous membrane of the intestine is continuous with the skin, always demand the removal of the mucous membrane at the mouth of the fistula by the use of the cautery or the knife. Large fæcal fistulæ are treated, if necessary, like an artificial anus—i. e., by opening the abdominal wall, detachment and resection of the part of the intestine in question, and enterorrhaphy. An attempt may be made at first to close them by funnel-shaped freshening of the fistulous tract, and by covering the defect in the skin with plastic skin flaps. The simplest way is, after the borders of skin have been freshened, to detach them sufficiently from the subjacent parts, in the neighbourhood of the fistula, to make a semilunar incision to relieve tension, and then lay the bridge-shaped skin flap thus formed over the fistula and suture it here. The incision for relieving tension is distorted into an oval cleft, and the fæces are then discharged through this, but not in so direct a way as before. An effort should then be made later to close this fistula by bringing about exuberant granulations, and by frequent cauterization (Dieffenbach). In suitable cases a pedunculated flap of skin may be used, and one edge of the flap left unattached.

CHAPTER XX.

INJURIES AND DISEASES OF THE RECTUM AND THE ANUS.

Examination of the rectum.—Malformations (imperforate anus).—Injuries.—Foreign bodies.—Inflammatory processes.—Furuncles.—Intertrigo.—Pruritus.—Eczema.—Proctitis and periproctitis.—Ulcers.—Fissures.—Fistulae.—Strictures.—Prolapse of the rectum.—Rectal hernia.—Prolapse of the invaginated colon.—Hæmorrhoids.—Tumours.—Resection and extirpation of the rectum.

§ 170. **Examination of the Anus and the Rectum.**—The external examination of the anus is best undertaken by having the patient bend over a table or a chair with his back to the light, or, still better, by letting him assume the knee-elbow position, or a lateral position upon an operating table. The buttocks are drawn apart and the patient made to bear down.

The anus is closed by the external sphincter, consisting of striated muscular fibres, and the internal sphincter made up of non-striated fibres. The latter lies partly above and partly within the external sphincter. The so-called third sphincter is a semilunar fold of mucous membrane on the right and anterior wall of the rectum, six or eight centimetres above the anus. Bougies and enema syringes are easily caught in this third sphincter.

The internal examination of the rectum is made, in the first place, by the introduction of the forefinger smeared with oil or vaseline, the patient either standing or assuming a dorsal, lateral, or knee-elbow position. The rectum is washed out beforehand, if necessary, with warm water, and the bladder emptied. This digital examination of the rectum is also of great importance in diseases of the urethra, prostate, Cowper's glands, the seminal vesicles, bladder, female sexual organs (vagina, uterus, ovaries and vicinity), of the pelvic bones, and intestines; also in tumours and abscesses of the peritoneal cavity, dislocations of the femur, ischiatic hernia, aneurisms of the gluteal artery, etc. The finger is introduced carefully, with a slight rotary movement and with the infliction of as little pain as possible, through the sphincter, and as high up into the rectum as possible.

As Nussbaum and Simon first showed, the entire hand may be introduced into the rectum when the patient is under the influence of an anæsthetic, and valuable information gained—e. g., in gynæcological cases, intestinal obstruction, diseases of the bladder, etc. The anus is first stretched as much as possible with the two forefingers, and then with the forefingers and middle fingers. Incisions on both sides of the margin of the anus are seldom necessary. After stretching the sphincter, the forefinger and the middle finger and then the whole hand are introduced into the rectum. It is possible, in some cases, to pass the hand up as far as the sigmoid flexure, and to palpate

the organs of the peritoneal cavity. The exploration of the rectum with the entire hand is, however, to be undertaken with great caution, as deaths have occurred in this way from rupture of this organ.

It is sometimes necessary, in place of subcutaneous stretching of the sphincter, to divide the latter and the skin along the posterior rhapshe as far as the coccyx (posterior sphincterotomy).

The incontinence of fæces that follows stretching or division of the sphincter usually disappears in a comparatively short time. It naturally continues longer after division, but the latter is seldom necessary.

Examination of the rectum with rectal bougies, which resemble œsophageal bougies, is especially adapted for the diagnosis of strictures situated high up, and the bougie is also used in irrigating the rectum and the large intestine or insufflating air. Rectal bougies are easily caught in the folds of the rectum or at the promontory, and may thus give rise to the erroneous impression that there is a stricture. Examination with bougies

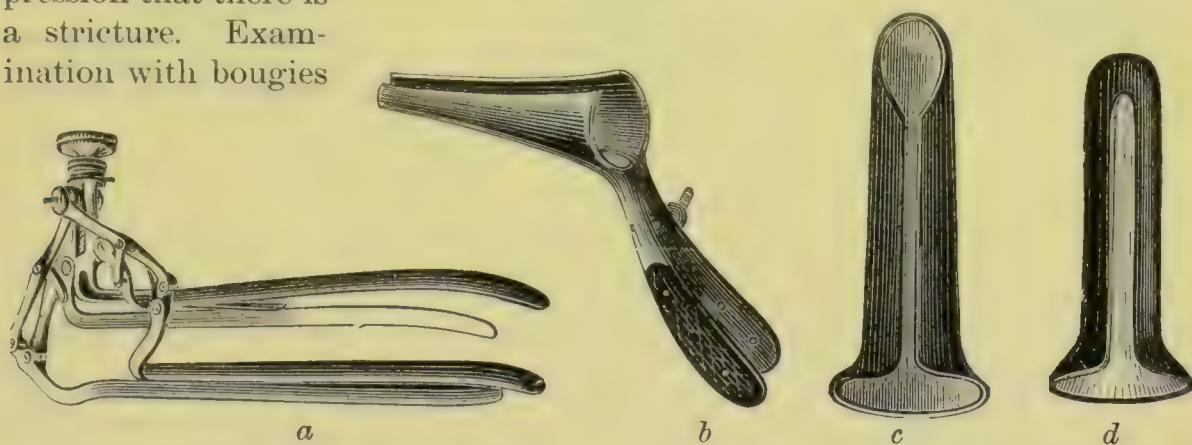


FIG. 460.—Rectal specula: *a*, Allingham's; *b*, Lane's; *c* and *d*, Fergusson's.

must also be made carefully. The instrument may be introduced, under normal conditions, to about the middle of the sigmoid flexure. In case the sigmoid flexure or its mesocolon is very long, the bougie can sometimes be felt through the skin in the right hypochondrium near the border of the liver, so that one might suppose it had been pushed through the transverse colon.

In order to inspect the mucous membrane of the rectum, use is made of rectal specula, which have the greatest variety of shapes (Fig. 460). They resemble in general vaginal specula. If the patient is anæsthetized and the sphincter has been stretched, Simon's or Sims's vaginal speculum may be used to advantage (see Surgery of the Female Generative Organs). Fergusson's rectal speculum (Fig. 460, *c* and *d*) is very serviceable, and causes scarcely any pain. By rotating it one can bring the whole of the mucous membrane of the rectum into view in the cleft.

Injections into the rectum and irrigation of the same with water are made use of, partly for diagnostic ends and partly for medicinal purposes or as enemata. Enemata are best given by means of an irrigator filled with lukewarm water, whose tube is introduced into the rectum. For self-administered enemata, the best instrument is an India-rubber tube with a bulb in the middle (Davidson syringe). One end is passed into the rectum and the other into a vessel containing lukewarm water. By compressing the bulb the water is forced into the rectum.

The old enema syringes, which unfortunately are still much used, are not to be recommended. Especially those with a horn tip have often caused wounds, ulcers, phlegmonous processes, and even perforations of the rectum. A soft, pliable rubber tube is far preferable, especially in children. Injury of the rectum is impossible with the former, even in dealing with unruly children.

Injection of water and insufflation of air or gas into the colon are best accomplished with the patient in a knee-elbow position, or in a dorsal or lateral position with elevated pelvis, after a rectal tube has been passed up into the sigmoid flexure.

Of other injections into the rectum, mention should be made of nutrient enemata in cases where the patient can not be fed through the stomach; also medicinal injections of the most varied kinds—e. g., opium, cocaine, wine, etc.—and finally the insertion of suppositories, etc. For the technique of rectal etherization the reader is referred to page 39 of Principles of Surgery.

§ 171. **Malformations of the Anus and the Rectum. Imperforate Anus.**—Among the congenital malformations of the anus and the rectum, imperforate anus is the most important. The rectum is formed from the lowest part of the embryonic intestine, which at first ends blindly. The anal opening is formed, like the oral aperture, by an involution of the epiblast, which begins in about the fourth week. This external involution unites later with the embryonic rectum to form an open passage. The rectum is at this time still in open communication with the end of the allantois—that is, the urachus and the subsequent bladder—and also with the Wolffian ducts, so that the intestine and the urogenital sinus have a common orifice (cloaca). At about the tenth week the individual parts become separated from one another, and the perinæum develops as a septum between the sexual organs and the lower part of the rectum.

Disturbances in development, whose causes are not surely known, give rise to the various forms of imperforate anus, with or without a cloacal opening—that is, with or without continued communication with the urogenital apparatus. Thus the involution forming the anus is sometimes absent, or it exists, but does not unite with the rectum, which remains a blind *cul-de-sac* or communicates with the urogenital apparatus. Imperforate anus is conditioned largely, according to Ahlfeld, upon the influence of an undue or abnormally long-continued traction upon the intestines on the part of the vitello-intestinal duct. As a result of this traction, the blind end of the rectum can not unite with the involution of the anus, which is advancing to meet it. It is well known that imperforate anus occurs in connection with congenital ectopia of the abdominal viscera, with defects of the intestines, resulting from their being tied off in a congenital, umbilical hernia, and with Meckel's diverticulum (see § 154, pages 9 and 10). These mal-

formations likewise arise, according to Ahlfeld, from extreme or abnormally long-continued traction of the vitello-intestinal duct upon the intestine.

We distinguish with Esmarch the following main types of imperforate anus :

1. Closure of the anus—that is, imperforate anus proper. The anal orifice is absent, and the rectum ends blindly near the cutaneous

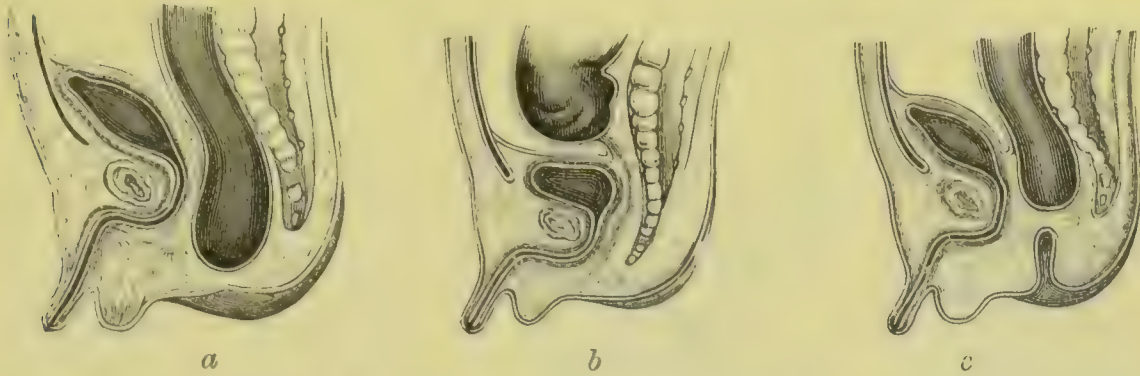


FIG. 461.—Imperforate anus (Esmarch).

covering (Fig. 461, *a*). The occlusion of the rectum is sometimes caused by a thin septum of epithelium, which can easily be divided with the finger, and sometimes by a thick layer of tissue, as in Fig. 461, *a*.

2. Occlusion of the anus and the rectum. The rectum and the anus are both absent. In place of the rectum there is a solid cord, and

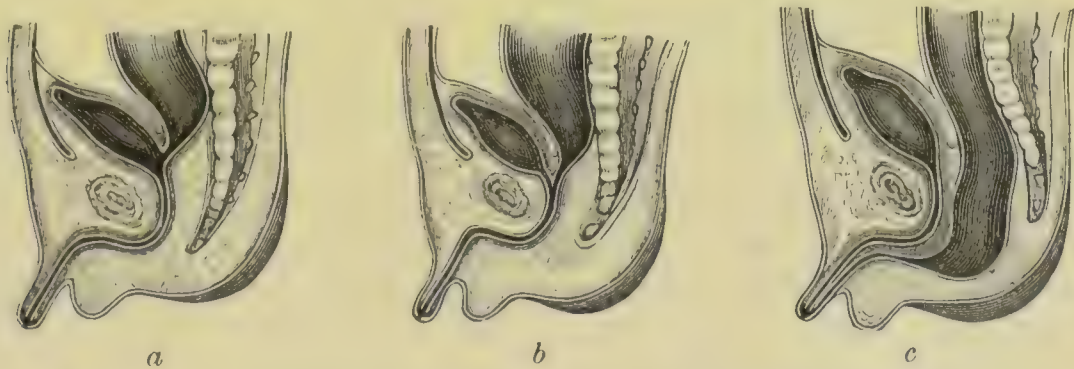


FIG. 462.—Imperforate anus with different cloacal openings in male children.

in place of the anal orifice there is a shallow depression. The colon ends blindly at some distance from the perinæum (Fig. 461, *b*).

3. Imperforate rectum. The rectum is closed, and the anal orifice is present, but ends blindly (Fig. 461, *c*).

4. Congenital cloacal openings—that is, abnormal outlets of the rectum, and in rare cases of the anus also, with coexistent imperforate anus. The rectum may, for example, open into the bladder (Fig. 462, *a*), the urethra (Fig. 462, *b*), the glans penis (462, *c*), the vagina (Fig.

463, *a*), and in very rare cases into the uterus. It should also be mentioned that the *cul-de-sac* of the anus, in case of imperforate rectum, sometimes opens into the vagina (Fig. 463, *b*). Between these separate forms there are numerous transitions. Sometimes extreme malformations exist. Slight observed absence of the rectum and the descending colon. In their place was a sac which communicated with the transverse colon and with the fundus of the bladder.

The clinical symptoms of imperforate anus vary according to the degree and the character of the malformation. In case of complete occlusion of the

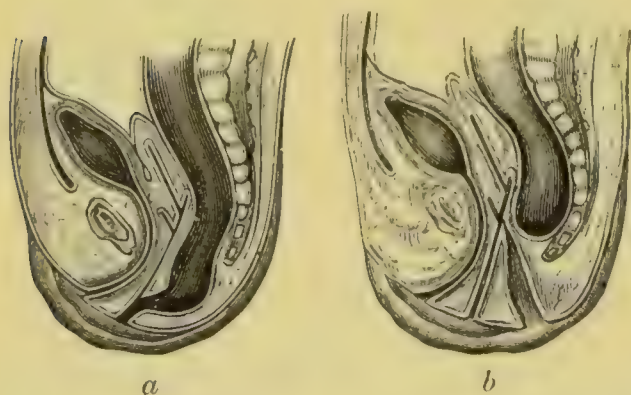


Fig. 463.—Imperforate anus with different cloacal openings in female children.

lower end of the rectum, the child generally dies in from four to eight days after birth if the malformation is not overcome or the fæces are not allowed to escape through an artificial anus, the symptoms being those of intestinal obstruction. If the rectum communicates with the bladder or the urethra, the same symptoms of retention of fæces usually appear as in complete occlusion of the rectum. If there is an open communica-

tion between the rectum and the vagina, the fæces may be discharged sufficiently through the latter, if the opening is large enough. A short time ago a child in this condition, three years of age, was brought to me by the mother. The discharge of fæces through the vagina had not been noticed until the child's second year.

The Treatment of Imperforate Anus consists in overcoming the malformation by operation as early as possible. The absence of the anus is often, unfortunately, not noticed at once by the midwife or physician, so that the children are not infrequently brought to the surgeon when already in a hopeless condition. Those cases are most favourable in which the anus is simply closed by a thin septum of tissue, which can be divided with the finger or a pointed bistoury. The thin septum sometimes ruptures spontaneously in such cases. If the lower end of the rectum reaches nearly to the cutaneous covering, the latter bulges outward from the pressure of the meconium in the rectum, particularly when the child cries or strains. After the septum has been divided with a pointed knife, the orifice is enlarged with a blunt-pointed knife, and the edges of the mucous membrane are sutured to the skin.

In all cases in which the rectum is closed by a thicker layer of tissue, and can not be felt from the outside, one should attempt to form

an anus at the normal place (proctoplasty). Proctoplasty is often a very difficult or altogether impossible operation. With the patient in the lithotomy position, the soft parts are divided in the direction of the blind end of the rectum by a longitudinal incision near the normal situation of the anus. It is a very good plan, before making the skin incision, to pass a silver wire transversely through the perineal region at a depth of four centimetres, and then, midway between the two punctures, to cut down upon the end of the rectum, which is usually held by the silver wire. By passing a catheter into the urethra of male children, and introducing the little finger into the vagina of females, one can protect these organs from injury. In cutting inward one should try from time to time to feel with the finger the fluctuating end of the rectum, which is filled with meconium. Resection of the coccyx facilitates finding the rectum. After the end of the rectum has been found it should be freed as completely as possible from its surroundings, without opening the peritoneal cavity, and drawn down to the skin, or at least sutured into the wound. If the tension is too great, one should make the edges of the skin as movable as possible by dissecting them up from the subjacent parts. The rectum is then opened by puncture with a knife, and, after the puncture wound has been enlarged by means of a blunt-pointed knife, the edges of the mucous membrane are sutured to the skin or to the wound. One may cut in to a depth of three or, at most, four centimetres, and if the rectum is not found the operation should be abandoned, as otherwise the peritoneal cavity will be opened, which must be avoided. If proctoplasty is impossible, there remains only the formation of an artificial anus—colostomy. This is best performed, after Littré, in the inguinal region on the sigmoid flexure, which is usually distended, and can therefore easily be found and conveniently fixed in the wound (see page 129). Esmarch recommends opening the peritoneal cavity through the perinæum and bringing into the wound one of the lower intestinal loops.

The prognosis of these operations is, generally speaking, unfavourable. Most children thus treated die from exhaustion, from septic cellulitis, or peritonitis. In case the child survives, cicatricial stricture of the newly formed anus must be guarded against later by the occasional introduction of rectal bougies. After the end of the rectum has been successfully opened the meconium sometimes fails to pass off sufficiently, because the muscles of the distended intestine are paralyzed. In such cases the meconium may be aspirated through an elastic catheter by means of a syringe, and peristalsis stimulated by careful massage and the use of electricity. Huetter recommended the insufflation of cigar smoke into the large intestine through an elastic catheter.

Imperforate anus and rectum are sometimes combined with an abnormal communication between the rectum and the urinary and generative organs, as described above. Children in whom the rectum empties into the bladder, which is observed only in boys, usually die soon after birth, in consequence of septic inflammation of the bladder. The operation in such cases is the same as given above. After the anus has been made, the fistulous tract, which is usually narrow and distorted or divided in the course of the operation, generally closes spontaneously. It may also be tied off and severed. In case the rectum empties into the vagina, the discharge of fæces is usually less impeded, so that one may delay the operation for a few months or years until the tissues have developed sufficiently. The operation consists here also in seeking out the end of the rectum from the place where the anus ought to be. One can facilitate the finding of the end of the rectum by passing a probe into the fistulous tract from within the vagina. Rizzoli's method is the best, and consists in separating the anterior wall of the rectum with the orifice of the fistula from the vagina, closing the opening in the latter by suture, and then fixing the lower end of the rectum in the wound at the site of the normal anal orifice. The method of Vicq d'Azyr is not so good. He leaves the opening in the vagina untouched at first, draws the end of the rectum into the wound in the perinæum, divides it, and sutures it to the edges of the skin. One would then be compelled to close the vaginal fistula later, or close the defect in the vagina at the same time with the operation, after freshening it and tying off the fistulous tract.

Congenital or acquired diverticula of the rectum are rare. They should be exposed from the outside, and extirpated as completely as possible.

§ 172. **Injuries of the Anus and the Rectum.**—Incised wounds of the anus are most commonly made by the surgeon. They heal, even when there is complete division of the sphincter, without permanent functional disturbance. The incontinence of fæces which exists at first as the result of division of the sphincter usually disappears in a comparatively short time.

Injuries of the rectum, especially those in its upper part, are always to be treated with special care. Perforating wounds of the rectum not infrequently have a fatal course in consequence of phlegmonous inflammation, which easily spreads in the cellular tissue about the rectum (periproctitis), and may lead to general peritonitis. We have sometimes to do with very complicated injuries, when, for example, the bladder, the urethra, and the pelvis, and in women the perinæum and the vagina, are injured. Here belong also the severe lacerations of the

vagina, the perinæum, and the rectum, which occur in labour. Severe injuries of the rectum and the neighbouring organs are also observed from a fall upon a sharp, perpendicular stake. We have already mentioned these impalement injuries on page 20. In gunshot wounds also there exist, as a rule, severe associated injuries, particularly of the pelvic bones, the bladder, the female generative organs, and the peritonæum. In connection with all injuries of the rectum with invasion of the peritoneal cavity, general peritonitis and septic proctitis easily ensue, if provision is not promptly made for the discharge of the pus by dividing the rectum in the posterior rhaps, with resection, it may be, of the coccyx, and by opening the periproctitic abscesses.

Rupture of the rectum in a vertical or transverse direction, in consequence of straining to evacuate hard and very large fæcal masses, has been observed in a few cases, especially among women (Majo and Ashton). We have usually to do with a rupture of the recto-vaginal wall above the sphincter, so that the fæces are discharged through the vagina. Spontaneous ruptures of the rectal wall sometimes occur in connection with diseases of the rectum—e. g., ulcers or stretching and thinning of the wall due to rectal prolapses and herniæ. Injuries of the rectum may also arise from the careless use of enema syringes and rectal bougies. The injuries produced by the stiff horn tips of enema syringes are in part simple tears of the mucous membrane, which sometimes lead to chronic ulceration, in part, however, complete perforations of the rectum with secondary septic inflammation of the rectal wall and the surrounding cellular tissue (septic proctitis and periproctitis). Death may be occasioned in this way, and we have therefore already stated on page 20 that these horn tips should be discarded, and that only soft, pliable tips of India rubber should be used. Enemata are best given by the use of an irrigator or an India-rubber tube provided with a bulb. Perforation of the rectum has also been caused by the unskilled forcible introduction of rectal bougies.

The results of injuries of the rectum above the sphincter depend chiefly upon the extent and the depth of the division in continuity and its character in other respects. Superficial wounds of the rectum without perforation usually heal without difficulty in spite of the contact of the fæces with the wound, if the secretions have free exit and the latter, together with the fæces, do not burrow behind the mucous membrane and occasion septic inflammation and fæcal extravasation. If the peritonæum has been opened and fæces have entered the peritoneal cavity, there quickly follows diffuse septic peritonitis, or, in favourable cases, an encapsulated fæcal abscess and burrowing of pus in the direction of the perinæum. Suppurative phlebitis may also develop after

injuries of the veins of the rectum, which sometimes spreads rapidly upward, and may lead to suppurative inflammation of the portal vein (pylephlebitis) and pyæmia.

Hæmorrhages from the injured rectal vessels should receive careful attention. These hæmorrhages, especially after an operation upon hæmorrhoids, are the more dangerous because they are often first recognised by the physician when the entire cavity of the rectum is filled with blood and the patient has become seriously anæmic. If the sphincter is drawn apart in such cases, the blood gushes forth partly in fluid and partly in coagulated masses, and the large number of clots that pass off in the next few days first show the inexperienced surgeon how dangerous the situation has been, and why the patient became so strikingly anæmic. One should therefore see that all those who undergo operations upon the rectum, or have been injured in this region, are carefully watched with reference to possible secondary hæmorrhages.

Another result of injuries of the rectum is the formation of cicatricial strictures, which may assume a marked degree. A short time ago I was obliged to extirpate the rectum after resection of the coccyx and a part of the sacrum, on account of an extreme traumatic stricture of the rectum above the sphincter with numberless fistulæ, all other treatment having proved fruitless. The rectum for a long distance was almost completely impassable. The patient was cured. After superficial tears of the rectal mucous membrane, long fistulous tracts easily develop. For the secondary conditions following injuries of the neighbouring organs the reader is referred to the surgery of the male and female urinary and sexual organs. We shall there take up more in detail the various kinds of fistulæ, the abnormal communications of the rectum with the bladder, lacerations of the perinæum, etc.

In treating injuries of the rectum, especially those above the sphincter, the first indication is to carefully arrest all hæmorrhage and have the patient strictly watched with reference to possible secondary hæmorrhages. Hæmorrhage from the lower part of the rectum is arrested by tying the bleeding vessels after the sphincter has, if necessary, been so far stretched as to allow the introduction of a speculum. In this way one can properly inspect the interior of the organ and catch and ligate any bleeding vessels. The arrest of hæmorrhage higher up in the rectum is attended with difficulties because the bleeding vessels can neither be properly seen nor caught. Packing the rectum with iodoform gauze is not sufficient in dealing with hæmorrhage from its upper part, and the same is true of compression by means of an India-rubber bag filled with water, glycerin, or air—the so-called col-

peurynter (Fig. 464). The latter is introduced into the rectum when empty, and then filled with from five to six hundred cubic centimetres of water. The tube of the colpeurynter is most simply closed by means of a silk thread tied tight. In all cases of severe hæmorrhage from the upper part of the rectum when delay is dangerous, the sphincter should be divided in the posterior rhapshe with the patient under an anæsthetic, and the lower part of the rectum also, if necessary, and then a Simon or Sims vaginal speculum introduced into the rectum and the bleeding vessels tied.

In other respects the treatment of wounds of the anus and the rectum conforms to general rules.

In all fresh wounds of the anus suture is a thoroughly good procedure, especially for the purpose of arresting hæmorrhage, but is often entirely unnecessary. For the suture of lacerations of the perinæum the reader is referred to the surgery of the female generative organs. In case of a wound of the rectum, the latter should be cleansed, to begin with, by irrigation with lukewarm water, and then, if necessary, the wound sutured with catgut. If the injury is severe and extensive and involves the entire thickness of the bowel, one should, as a general rule, not insert too many sutures, but preferably pack the wound with iodoform gauze in order to assure an escape of the secretions. In case of severe contused wounds, gunshot wounds, etc., suture of the wound should be abandoned and gauze drainage substituted. To facilitate the evacuation of the fæces and the escape of the wound secretions in cases of severe injury of the rectum, division of the sphincter in the posterior rhapshe is especially to be recommended. If periproctitic inflammation and fæcal extravasation already exist, the vicinity of the rectum must be thoroughly drained, and to accomplish this it may be necessary to resect the coccyx and the lower part of the sacrum. The patient should assume a half-sitting posture in bed upon an air or water cushion, as after extirpation of the rectum, inasmuch as the escape of the secretions of the wound is thus facilitated. In case of a gunshot wound of the rectum, one may also place the patient in a permanent bath of lukewarm water (see Principles of Surgery, p. 179).



FIG. 464.—Colpeurynter.

For the treatment of associated injuries—e. g., of the pelvis, the bladder, etc., and also for strictures and fistulæ—the reader is referred to the proper paragraphs. See also the treatment of peritonitis (§ 158),

and of inflammations of the rectum and its vicinity (proctitis and periproctitis, § 174, page 149).

§ 173. **Foreign Bodies in the Rectum.**—As we have already seen when treating of foreign bodies in the stomach and the intestinal canal (§ 166, page 100 ff.), the greatest variety of objects that are swallowed passes off *per rectum*. The time required for the passage of a body from the mouth to the anus is very variable. In the majority of cases it is between twenty-four hours and from six to nine days (Goodsall). We have already mentioned (§ 166) that the most varied objects enter the rectum from without. Especially insane and hysterical patients, criminals and prostitutes, introduce the most surprising things into the rectum. I therefore refer the reader to what is said in § 166. In the articles of Nussbaum and Esmarch (*Deutsche Chirurgie*, Lief 44 and 48) there are numerous reports of incredible cases.

Foreign bodies may remain lodged in the rectum, perforate it, and then occasion dangerous inflammation of the organ itself, the surrounding cellular tissue, and, it may be, the peritonæum. Foreign bodies sometimes make their way from the rectum into the neighbouring organs, especially into the bladder and the vagina, or the reverse may be true—i. e., foreign bodies in the latter—e. g., uterine pessaries may perforate the rectum.

Hardened masses of faeces may remain for months or years even in the rectum and be erroneously taken for strictures or tumours until the nature of the supposed stricture or tumour is recognised after a thorough examination by a competent physician. Biliary calculi and fruit stones often form the nuclei of these faecal concretions. The latter sometimes consist of a great number of fruit stones, especially those of the cherry and the plum. The faecal balls are often as hard as stone, and they are sometimes covered with a layer of lime, so that they more or less resemble genuine stones (see also page 101, *Intestinal Concretions*).

The symptoms of foreign bodies in the rectum vary according to their size and their other characteristics. By far the larger number of such bodies pass off through the anus without doing any harm. If they remain lodged in the rectum, there ensues corresponding constipation, amounting even to complete obstruction, attended finally with faecal vomiting, it may be, as in other forms of occlusion of the intestinal canal. After remaining a long time in the rectum, foreign bodies sometimes produce chronic catarrh, frequently attended by profuse secretion and circulatory disturbances, with swelling of the mucous membrane and prolapse of the same. Pressure of the foreign body upon the urethra may cause difficulty in the passage of urine, amounting sometimes to complete retention. Pointed and sharp-edged bodies give rise to pain of a darting character, and such bodies not infrequently lead to superficial or deeper injury of the rectum or to its perforation, with death from sloughing periproctitis or peritonitis. Foreign bodies, as has been said, sometimes make their way from the rectum into the neighbouring organs, especially into the bladder, where they may become the nuclei of vesical calculi; also into the vagina, the uterus, or the peritoneal cavity. Esmarch mentions a very striking case observed by Malin. A pregnant woman had swallowed two fish bones which remained lodged in the rectum. The bones made their way from the rectum into the uterus. Premature birth occurred

in the fifth month, and one bone was found in the shoulder and the other in the thigh of the foetus. For a detailed description of the symptoms and diagnosis of foreign bodies the reader is referred to § 166, page 100 (Foreign Bodies in the Stomach and Intestinal Canal). The diagnosis of foreign bodies in the rectum is easy when they can be felt by the introduction of the fingers. If the body can not be felt with the finger, the diagnosis remains in doubt. Foreign bodies in the upper part of the rectum are frequently not recognised unless the statements of the patient give definite grounds for forming an opinion.

The extraction of foreign bodies is often very simple. If the body has become impacted by assuming a transverse position, one should attempt to give it a longitudinal direction and then to extract it. It will often be found necessary to stretch or divide the sphincter with the patient under an anæsthetic. Hardened faecal balls are softened by washing out the rectum by means of an irrigator, and then, if necessary, broken up with forceps, etc. Any injuries or inflammations of the rectum and its surroundings that may be occasioned by foreign bodies are treated in accordance with the rules applicable in such cases (see § 172, Injuries, and § 174, Inflammatory Processes of the Rectum).

§ 174. **Inflammatory Processes of the Anus and Rectum.**—Furuncles frequently occur at the anus, which should be incised as early as possible under cocaine. If furuncular abscesses are not thoroughly opened, they frequently give rise to fistulæ (see § 175, page 153).

Intertrigo is an acute dermatitis, commonly known as "chafing," which occurs among fat people in consequence of the friction of the buttocks and the secretion of sweat from prolonged walking on hot days, also among young children with diarrhœa, among uncleanly persons, etc. The discomfort consists essentially in a painful smarting and in swelling and hyperæmia. The treatment consists in bathing the parts frequently with cold water, and also in the inunction of unguentum diachylon or hard suet, lard, zinc or lead ointment, powdering the parts with oxide of zinc or amylum, and the insertion of cotton or boric lint, in order to prevent the friction of the buttocks. Persons who are predisposed to intertrigo should resort to the above measures before taking long walks. They should also bathe the parts frequently with cold water. Persons with long hair about the anus should not cut it, as troublesome smarting and swelling likewise arise from the friction of the short hairs.

Pruritus or itching of the anus is usually the result of hyperæsthesia of its cutaneous nerves in connection with various affections of the anus and the rectum—e. g., among persons of sedentary habits with hemorrhoids or catarrhal or ulcerative diseases of the rectum, after errors in diet, after partaking of certain kinds of food (lobster, salmon, venison) and among children with threadworms. It also occurs in connection with affections of the liver, etc. The severe itching occurs especially at night and may become intolerable. There is not infrequently a pronounced eczema. Fissures and indurations of the skin develop from constant scratching.

The treatment of pruritus and eczema of the anus consists chiefly in re-

moving the above-mentioned causes. The most scrupulous cleanliness locally is important, also bathing the parts with cold water, the application of unguentum diachylon, oxide of zinc and amylum, with the insertion of a little boric lint or cotton, and the use of cathartics if necessary.

Inflammation of the Rectum (Proctitis).—Acute proctitis is characterized by the same anatomical changes essentially as the acute catarrh of other mucous membranes—that is, by hyperæmia and swelling. The inflammatory swelling in the rectum is not infrequently well marked, and is often combined with desquamation of the epithelium, comparatively abundant secretion of mucus, and inflammatory infiltration of the submucous tissue. Circumscribed eschars are sometimes formed in the mucous membrane, and, after the scabs are cast off, superficial ulcers, which either heal promptly or become deeper and lead, it may be, to secondary inflammatory infiltration and hypertrophy of the perirectal cellular tissue or to periproctitic abscesses. Rectal fistulæ often result in such cases, or a fistulous communication with the vagina, the bladder, etc.

In chronic proctitis the inflammatory infiltration of the mucous and submucous coats, as well as the hypertrophy of the muscular layer, become especially prominent. There are found, therefore, in chronic proctitis diffuse thickenings of the rectal mucous membrane extending into the perirectal cellular tissue, and often circumscribed polypous growths and ulcers.

Acute and chronic inflammations of the rectum arise partly in the organ itself in consequence of the action of local irritation, and are induced in part by inflammation of the neighbouring organs, particularly the bladder, prostate, vagina, and uterus. Primary proctitis is observed after the action of cold, in consequence of the presence of foreign bodies or impacted fæces, from the presence of worms, in connection with disturbances of circulation—e. g., from hæmorrhoids, temporarily also after operations in the rectum, etc. Many forms of proctitis are conditioned upon the action of special microbes. Here belongs the proctitis resulting from gonorrhœal infection, or attending syphilis, tuberculosis, diphtheria, and dysentery.

The symptoms of acute proctitis are chiefly a burning sensation, or sometimes very severe pain in the rectum with tenesmus and spasm of the sphincter and the levator-ani muscle. Disturbances in urination often exist in consequence of irritation of the trigonum vesicæ, amounting, it may be, to complete retention, as the result of spasmodic contraction of the neck of the bladder. The mucous membrane of the rectum is sometimes so swollen that an inflammatory prolapse is formed. The secretion of the rectal mucous membrane is often stained

with blood at first. Later it is purely mucous or more suppurative. The course and termination of acute proctitis depend chiefly upon its cause, or rather upon the possibility of speedily overcoming its cause.

Simple catarrhal proctitis gradually disappears, as a rule, in from eight to ten days. If the cause continues, as in gonorrhœal infection, for instance, the disease is more protracted, and may then extend to the colon and lead to profuse diarrhœa.

The results of acute proctitis have already been indicated, especially the formation of ulcers and fistulæ and the occasional occurrence of perforation of the rectum with secondary periproctitic abscesses.

Acute proctitis frequently passes into the chronic form, which is usually characterized by an abundant secretion of a tenacious, gelatinous mucus or pus, combined with ulcers and fistulæ.

The treatment of proctitis is directed chiefly against its cause, which is therefore to be exactly determined by careful examination. Foreign bodies and impacted fæcal masses are to be removed as soon as possible. In case worms are found in the passages, saline cathartics are given and the rectum is thoroughly irrigated with the patient in a knee-elbow posture. Vix and Esmarch recommend especially solutions of *sapo medicatus* (0·20–0·5 : 100). The remainder of the treatment consists of rest in bed, sitz baths, warm injections and irrigations of the rectum, cathartics in case of constipation, etc. If there is severe tenesmus, warm sitz baths, and also the use of morphine, opium (for injections and suppositories), and leeches about the anus are to be recommended.

In case of gonorrhœa, thorough irrigation of the rectum with solutions of salicylic acid, salicylate of soda, boric acid, liquor plumbi subacetatis dilutus, or nitrate of silver (3–4 : 1,000) should be employed.

In chronic proctitis astringent injections into the rectum are serviceable. Esmarch recommends the local use of balsam of copaiba and oil of turpentine in the form of suppositories, as well as sea baths. The rectum should be examined for ulcers and fistulæ. The treatment of these is given on pages 151–155.

Inflammation of the Cellular Tissue in the Vicinity of the Rectum (Periproctitis).—Periproctitis originates usually from the rectum after injuries and diseases of the same—e. g., from the presence of foreign bodies, after gunshot wounds, after operations upon the rectum, after perforation of ulcers, etc. In other cases periproctitis is the result of injuries and diseases of the neighbouring organs, especially the bladder, the urethra, the vagina, the uterus, the pelvic bones (caries, compound fractures), etc. If phlegmonous inflammation of the perirectal cellular tissue follows perforation of the rectum, it usually spreads

rapidly with high fever, and the cellular tissue suppurates, giving rise to extravasation of fæces, or a circumscribed fæcal abscess. The neighbourhood of the anus is attacked comparatively late by the inflammation, because the perirectal cellular tissue is shut off below by the perineal fascia and the levator-ani muscle. On the other hand, no obstacle stands in the way of the extension of the inflammation upward in the loose cellular tissue. The levator-ani muscle forms below a diaphragm, as it were, of the pelvic outlet. All abscesses which lie above the levator-ani muscle, or between it and the rectum, easily spread in an upward direction, while those in the neighbourhood of the anus, below the levator ani, point externally, because the muscle named and its fascia render extension in an upward direction difficult

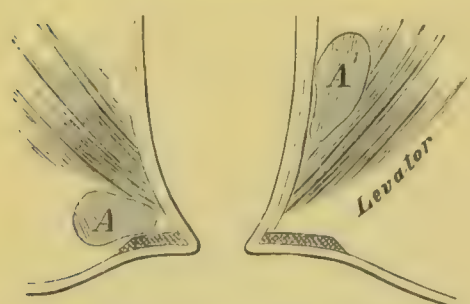


FIG. 465.—Abscesses (A and A') above and below the levator ani muscle (diagrammatic).

(see Fig. 465). The neighbouring organs are not infrequently involved, and the pus may rupture into the bladder and the urethra with corresponding extravasation of urine, or into the uterus and the vagina. This course is sometimes reversed—that is, after injuries or carcinomatous disease of the bladder, the urethra, the uterus, or the vagina, a secondary periproctitic abscess is

formed, which ruptures into the rectum. Metastatic abscesses in the neighbourhood of the rectum are sometimes observed in pyæmia and typhoid fever. Some of the cases, as has been said, run a very acute course, while in others the course is more subacute, or, it may be, very chronic—e. g., in tuberculosis of the rectum and the pelvic bones or after injuries. Very numerous fistulous tracts, twenty or thirty it may be, are sometimes formed in such cases of chronic periproctitis following injuries, attended not infrequently by such induration and stenosis of the rectum and its surroundings that one might believe it to be carcinoma. I recently saw such a case of very chronic periproctitis following impalement upon a wooden stake which had occurred five years before. It is sometimes necessary, in such cases, to extirpate the rectum which has become extremely constricted through cicatricial contraction and perforated by numerous fistulæ.

The symptoms of acute periproctitis are chiefly severe pain, especially during defecation, and high fever. Upon palpation of the perineal region, one usually feels deep down a hard, very painful infiltration. In case suppuration already exists, fluctuation is felt with difficulty or not at all through the skin and the perineal fascia. The skin about the anus is usually hyperæmic and more or less œdematous.

If the finger is introduced into the rectum, the patient complains of severe pain, and one finds in typical cases that the rectum is constricted by a hard or already fluctuating swelling which is to be felt at a definite place. In women, examination through the vagina is important.

Essentially the same symptoms exist in chronic cases, but they increase only very gradually.

Every case of periproctitis goes on to suppuration, and very often to sloughing of the cellular tissue. The abscesses rupture into the rectum, into the neighbouring organs, or externally. If a means of escape for the pus is not provided by a sufficiently prompt incision, death may follow, especially in acute cases, from septicæmia, peritonitis, or pyæmia. The sloughing of the perirectal cellular tissue sometimes extends to the rectum itself and to the skin. The periproctitic abscesses originating in the pelvic bones are the most favourable, while those following perforation of the rectum and diseases and injuries of the bladder, the uterus, and the vagina combined, it may be, with extravasation of urine and fæces, have the worst prognosis.

The treatment of phlegmonous inflammation of the perirectal cellular tissue consists in a prompt and free incision, even though fluctuation can not be made out. The left forefinger is introduced into the rectum until the infiltrated area is reached, and then the skin and fascia are incised with a pointed scalpel, whereupon a dressing forceps is pushed up into the abscess. The opening must be as large as possible, and the abscess cavity scraped out and drained. This method of opening perirectal abscesses by a perineal incision is to be preferred to every other one, including incision from within the rectum. In case of diffuse suppuration around the rectum several incisions may be necessary. If the rectum is separated from its surroundings and is perforated, the best way is to divide the lower part of it from the abscess or from the place of perforation downward, and all fistulous tracts must likewise be divided upon a grooved director. Access to the rectum may be facilitated by stretching or dividing the sphincter. We have already mentioned that in very chronic cases of periproctitis with extreme cicatricial stenosis and numerous fistulæ the extirpation of the rectum may become necessary.

For the treatment of rectal fistulæ and the complications arising in the adjacent organs, especially the bladder and the urethra, the reader is referred to the proper paragraphs.

Ulcers of the Anus and the Rectum.—Soft chancres about the anus are observed especially among women, caused by infection from the secretion of soft chancres of the vulva or the vagina, also from sodomy,

or in consequence of the transmission of chancre virus by the finger. Phagedenic chancre may cause marked destruction of the rectum.

Primary syphilitic chancres of the anus and the rectum arise particularly from infection in connection with sodomy. The most common secondary syphilitic affections of the anus and the rectal mucous membrane are the broad condylomata which form characteristic, moist, papillary growths in the vicinity of the anus. The secondary ulcers of the rectal mucous membrane in the tertiary period of syphilis arise usually from the breaking down of circumscribed gummata or diffuse gummatous infiltrations. Marked strictures of the rectum develop from cicatrization of these extensive syphilitic ulcers, of which we shall speak more in detail in § 176.

Tubercular ulcers of the anus and the rectal mucous membrane are not uncommon, and usually occur among phthisical patients. Hartmann found among 626 phthisical subjects fistulæ and ulcers in thirty-one cases. Tubercular abscesses and fistulæ of the anus are the result of a purely local invasion of tubercle bacilli, which are conveyed with the fæces and attack by preference the mucous membrane of the rectum. Tubercular ulcers result from the caseous degeneration of tubercles or of the circumscribed or diffuse tubercular infiltration of the mucous membrane and subcutaneous cellular tissue (tubercular proctitis and periproctitis). In some cases there is a single large ulcer of the anus and neighbouring skin, with abundant granulations, which resembles a carcinoma. It is characteristic of tubercular ulcers of the anus and the rectum that miliary tubercles are almost always to be found in the vicinity of the ulcers; also that the latter have a cheesy base, and the caseous softening often spreads over large areas of the rectum. The diagnosis is usually made from the microscopic examination and the detection of tubercle bacilli.

The prognosis of tubercular ulcers and fistulæ of the anus and the rectum is very unfavourable. Progressive destruction of the rectum is usually observed. It is characteristic of tubercular fistulæ in ano that they usually do not heal at all after the operation, or very soon undergo caseous softening again and break open. Tuberculosis of the rectum and the testicle are among the forms of local tuberculosis that have the worst prognosis.

Ulcers sometimes arise from chronic catarrhal inflammation of the rectum, especially after gonorrhœal infection, in consequence of desquamation of the epithelium or of suppuration of the solitary glands of the rectum (follicular ulcers). Follicular ulcers present at first single or multiple losses of substance of the size of the head of a pin, and sometimes occur in large numbers. By coalescence of the

small, single ulcers, extensive ulcerations may result, which sometimes lead to progressive destruction of the surrounding tissue.

The ulcerative destruction that occurs in the course of dysentery takes place chiefly in the upper part of the rectum and in the colon. It often leads to perforation and the formation of a periproctitic faecal abscess or to general peritonitis.

For cancerous ulcers the reader is referred to Carcinoma of the Rectum.

The symptoms of the forms of ulcer that have been mentioned are, generally speaking, the same as those attending chronic proctitis. In case of large ulcers there is usually a corresponding discharge of pus and blood. Diarrhœa often exists as well as tenesmus and pain, especially during defecation. In case of ulcers near the sphincter, painful reflex spasm of the latter (sphincterismus) is often present, resulting from irritation of the sensory nerves on the surface of the ulcer. Fistulæ are very common in connection with ulcers. In every rectal ulcer, perforation of the rectum with all its dangers, especially periproctitic abscess, cellulitis, peritonitis, etc., is to be feared.

A thorough examination not only of the rectum but of the entire body, and a careful history from the patient, are necessary in all ulcers of the rectum, in order to be sure of the character of the process. One should have in mind especially syphilis, tuberculosis, gonorrhœa, etc.

The treatment of ulcers of the anus and the rectum depends partly upon their cause. In addition to local treatment, that of a general constitutional character is of the greatest importance, especially in dealing with tubercular and syphilitic ulcerations.

Local treatment requires that the ulcers be made properly accessible by stretching the sphincter, or, if necessary, dividing it, and the anal portion of the rectum in the posterior rhapshe as far as the coccyx, and by the introduction of a Simon or a Sims speculum. The special treatment of the ulcers conforms to general rules. Soft chancres, gonorrhœal ulcers, and primary syphilitic ulcers are treated in the same way as upon the external genitals (see these). In dealing with secondary syphilitic ulcers, a general antisyphilitic treatment (inunction, iodide of potassium, etc.) is necessary in addition to that of a local character, such as the use of astringents, cauterization, or scraping with a sharp spoon. In case of tubercular ulcers, a very energetic local treatment should be adopted as quickly as possible, including excision of the focus of the disease, the use of Paquelin's cautery, etc. For the treatment of complications on the part of the neighbouring organs, especially periproctitis, the reader is referred to page 149.

The treatment of strictures following ulceration is described in § 176, page 157.

Fissure of the Anus and the Rectum.—By fissure of the anus and rectum is understood a superficial tear or excoriation of the mucous membrane, which gives rise to a corresponding ulcer. It occurs by preference among persons with chronic constipation, in consequence of the passage of large, hard faecal masses, from small foreign bodies, from catarrhal inflammation of the rectum, among women with leucorrhœa, in connection with hæmorrhoids, and, finally, in connection with syphilis, where we usually have to do with multiple fissures. The fissures are found principally near the sphincter, and are therefore very commonly attended by the above-mentioned painful reflex spasm of the sphincter. The pain usually radiates in the direction of the genito-urinary organs and the thighs, and almost always occurs after defecation. Sphincter spasm is observed especially among nervous persons, and is conditioned upon irritation of the sensory nerve filaments upon the surface of the ulcer. The duration and the degree of these pains vary greatly. There is sometimes only a slight smarting, while in other cases the pain is very severe, so that a thorough examination of the rectum is only possible with the patient under an anæsthetic. Local anæsthesia with cocaine—in the form of suppositories, for example, which are inserted into the anus—is very serviceable. Upon examination with a rectal speculum, one finds the typical fissure to be a usually superficial, elliptical ulcer ordinarily on the posterior margin of the anus, less often in front or on the side. The edges of a fissure which has existed a long time are often strikingly indurated, as in syphilitic ulcers. If several fissures or ulcers exist they are usually caused by syphilis.

In mild cases a spontaneous cure is not infrequent, or the application of a nitrate-of-silver stick is sufficient. Cauterization of the fissure with the galvano-cautery or the thermo-cautery is very serviceable. The exact cause of the fissure should always be determined, and the treatment directed against this. The constipation which so frequently exists should be treated by enemata. In case of severe spasm of the sphincter, division of the fissure by a longitudinal incision extending into the sphincter is necessary, after it has been exposed by means of a rectal speculum. Stretching the sphincter is also very beneficial; it is not so effective, however, in cases of very painful spasm, judging from my experience, as incision of the sphincter. Indurated edges of the fissure are excised or removed by galvano-caustic action.

§ 175. **Fistulæ in Ano.**—By fistulæ in ano are understood sinuses in the neighbourhood of the anus and the lower part of the rectum.

The following varieties are distinguished, according as these fistulæ develop, from without or within the rectum, and form complete or blind canals :

1. Incomplete external fistulæ—that is, sinuses which extend from the neighbourhood of the anus to a certain height in the anal region, but do not perforate the wall of the rectum (Fig. 466, *a*).

2. Incomplete internal fistulæ (Fig. 466, *b*), which start from the rectum and end blindly in the vicinity of the anus, not perforating the skin.

3. Complete rectal fistulæ (Fig. 466, *c*)—that is, those in which the external opening of the fistula at the anus or in the perinæum is in open communication with the interior of the bowel by means of a

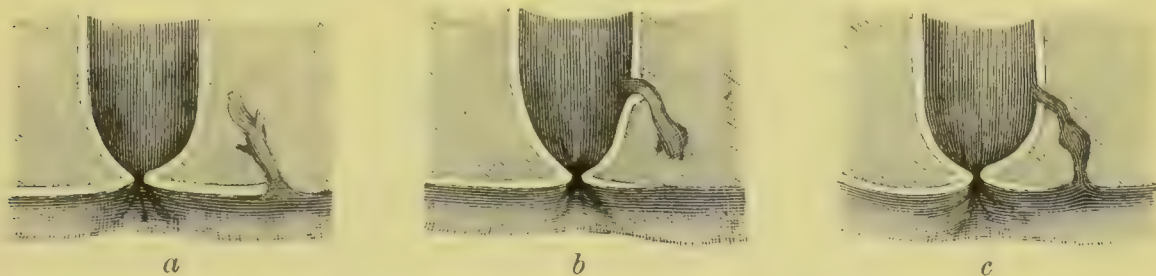


FIG. 466.—Varieties of fistula in ano:
a, incomplete external; *b*, incomplete internal; *c*, complete fistula.

longer or shorter sinus, so that one can pass a probe from the outside through the sinus into the rectum.

Rectal fistulæ develop partly from the outside, in the neighbourhood of the anus, and partly from within, in the rectum, and in both cases they result usually from inflammatory processes or from injuries. Ulcers are the main cause of fistulæ that originate within the rectum. At the beginning of the fistula formation the symptoms of that inflammatory process or injury are usually present from which the fistula originates, especially a furuncle or ischio-rectal abscess, chronic proctitis, periproctitis, ulcer of the rectum, or tuberculosis, gonorrhœa, or syphilis. The discomfort arising from fistulæ is often so slight that the patient knows nothing of their existence for a long time, until his attention is called to them by the increasing purulent discharge. The amount of discharge is very variable. A fæcal admixture is infrequent, because the sinus usually runs obliquely and the opening in the rectum is small. The incomplete internal fistulæ are the most painful, because retention of the secretion is more likely to occur here. All fistulæ, whether they be complete or incomplete, fail to heal spontaneously, because decomposing secretion, in part mixed with fæcal matter, accumulates in the sinuses, and because the latter are constantly drawn open by the contraction of the sphincter.

Fistulæ not infrequently develop between the rectum and the neighbouring organs, especially the vagina, urethra, bladder (recto-vaginal, recto-urethral, and recto-vesical fistulæ), etc.

The prognosis of simple fistulæ in ano is favourable, but that of tubercular fistulæ, as we have already said (page 150), is not. The cure of recto-vesical and recto-urethral fistulæ is often difficult.

The treatment of fistulæ in ano consists chiefly in opening up the sinus in its entire extent. A cathartic should be given the day before,

and the rectum thoroughly washed out before the operation. An anæsthetic is usually necessary. The patient lies on his side or in the lithotomy position. A speculum is introduced into the rectum—e. g., one of those represented on page 135. To expose sufficiently the internal opening of fistulæ that are located high up in the rectum, stretching the sphincter is often necessary as a preliminary to the introduction of a Simon vaginal speculum into the rectum. It may in some cases be necessary to divide the anal portion of the rectum in the posterior rhapshe. In case of a complete fistula, a grooved director is introduced through the external opening of the fistula into the rectum, and the sinus then divided throughout its entire extent upon the director. In case of very narrow sinuses, correspondingly small directors are to be used (Fig. 467, *a*). The directors made of pliable, smooth tin, recommended by Esmarch, are also very serviceable. Incomplete external fistulæ are operated upon in the same way as those which are complete—that is, the former are converted into complete fistulæ by pushing a probe or director through the mucous membrane of the rectum, and then dividing the complete fistula upon the director. In case of an incomplete internal fistula, the process is reversed, the probe being introduced into the sinus from the internal opening to a point beneath the

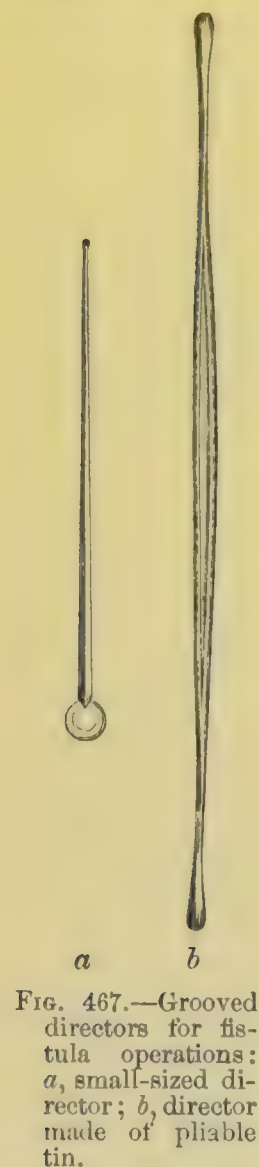


FIG. 467.—Grooved directors for fistula operations: *a*, small-sized director; *b*, director made of pliable tin.

skin of the anal region by curving the end of the probe to correspond with the course of the sinus, and then the skin and the sinus divided. The pliable probes of block tin are especially suited for this purpose. In treating all fistulæ which pass through or below the sphincter, the latter must of course be divided. The incontinence of fæces, which then usually exists at first, is generally of short duration.

The complicated fistula knives and fistula scissors which were formerly much used have been abandoned. The so-called "gorget" also, by the use of which injury to the rectum was to be prevented, is unnecessary. It is important, above all, to perform the operation thoroughly—that is, to find all the fistulæ, and especially all the internal openings.

All other methods of operating—e. g., the use of ligatures or the galvano-cautery—are much more roundabout than simple division of the sinus with the knife. In the operation by ligation, which is scarcely used any longer, a silk thread or elastic thread of India rubber is drawn through the sinus and tied tight. After a time the thread cuts through. The galvano-caustic loop and the thermo-cautery can also be dispensed with for the most part, though the latter is very serviceable for arresting hæmorrhage when hæmorrhoids exist at the same time. I have recently used the thermo-cautery a good deal in dividing extensive fistulous tracts, and have been extremely pleased with the results. The hæmorrhage must be carefully arrested after operation upon a fistula, as after every operation upon the rectum. The after-treatment is very simple. I do not always use opium to check passages from the bowels. Somewhat scanty diet is given, and easy defecation is secured by means of enemata. As a dressing, a little cotton is laid between the buttocks. The fistula should be cauterized with nitrate of silver as early as possible to promote granulation.

All tubercular fistulæ, as was mentioned on page 151, must be very energetically scraped or excised.

The treatment of recto-vaginal, recto-urethral, and recto-vesical fistulæ conforms, generally speaking, to the same rules that apply to vesico-vaginal fistulæ (see § 256). The openings of the fistulæ should be made sufficiently accessible, detached from their surroundings, freshened, and closed by suture. The closure of recto-vaginal fistulæ by the formation of a flap, much as in Tait's perineoplasty (see § 255), is strongly to be recommended in some cases.

§ 176. **Strictures of the Rectum.**—The following forms of stricture of the anus and the rectum may be distinguished with reference to their origin: 1, Congenital strictures; 2, inflammatory strictures, from inflammatory processes, especially syphilis; 3, cicatricial strictures, from cicatricial contraction; 4, those due to tumours of the rectum; 5, those resulting from diseases of the neighbouring organs.

Congenital strictures may arise from congenital folds of mucous membrane and valves. The stenosis is sometimes uniform and involves a large part of the rectum, as in Fig. 468, for example, after an observation by Ammon. Marked congenital strictures of the anus and the rectum usually

cause corresponding difficulty in defecation immediately after birth. They are to be regarded, as it were, as an incomplete atresia of the rectum (see page 136, Imperforate Anus). In other cases serious disturbances arise only after years. Congenital strictures are sometimes the cause of an increasing prolapse of the rectum. Inflammatory and cicatricial strictures occur after



FIG. 468.—Congenital stricture of the rectum in a man seventy years of age who had suffered during his whole life from obstinate constipation (Ammon).

injuries and various kinds of inflammation, especially those involving loss of substance of the rectum—e. g., gangrenous destruction, ulcers, syphilis, after operations, etc. Chronic catarrhal inflammation of the rectum also, with circumscribed and diffuse induration and contraction, may lead to extreme stenoses. The location and degree of the strictures vary greatly. The rectum is usually distended above the stricture, in consequence of the retention of the fæcal masses, and the wall of the rectum is hypertrophied, the more so the narrower the stricture is.

The principal symptom of stricture is difficulty in defecation, which may amount to complete obstruction. The latter may result more or less suddenly by closure of the bowel, from the fact that the mucous membrane above the stricture, which is stretched by the retained fæcal masses, comes together like a valve. The shape of the fæces is characteristic in stricture. They are diminished in diameter, narrow, thin, ribbonlike, or in the form of small lumps. When the stricture has a high location the fæces are usually unchanged in shape, because they are here of a less solid consistence and pass through the constricted part without special difficulty if

the stenosis is not extreme. Gradual prolapse of the rectum often occurs in connection with stricture.

In extreme cases of stricture of the rectum there finally result gradually increasing disturbances of nutrition in consequence of defective digestion, which may amount to pronounced cachexia. In the worst cases death may ensue from fæcal obstruction, from perforation of the distended intestine above the stricture with phlegmonous periproctitis and peritonitis, or, finally, from increasing exhaustion. Even marked rectal strictures with a high location not infrequently remain unknown during life. The trouble drags along for years, and the stenosis is first discovered at the autopsy.

In every case of obstinate constipation the rectum should be examined with the finger with reference to the existence of a stricture. Strictures of the anus and the lower part of the rectum are easily recognised by the introduction of the finger. In strictures with a high location the examination should be made while the patient is standing, and he should be required to bear down, or it should be made under an anæsthetic after stretching the sphincter. The examination with rectal bougies is always uncertain, because they are easily caught in the folds of mucous membrane. In doubtful cases of extreme stricture in the upper part of the rectum one may, if necessary, make a rectal examination with the whole hand after stretching the sphincter, or dividing the same and the anal portion of the rectum in the posterior rhapshe.

The Treatment of Strictures of the Rectum depends chiefly upon their cause and their character. If the stricture has arisen from inflammation of a neighbouring organ, this should receive proper treatment. Tumours, such as carcinomata of the rectum, must be extirpated. Congenital strictures resulting, for example, from congenital folds in the mucous membrane are to be divided, etc. The special treatment of rectal strictures due to organic changes in the rectum, especially cicatricial strictures, is as follows:

1. Gradual dilatation with bougies. Rectal bougies (Fig. 469) are sometimes elastic, like urethral bougies, and they are sometimes made of hard India rubber or of wood, metal (tin, steel, brass, etc.), glass, etc. B. Credé recommended instruments made in imitation of Hegar's uterine bougies for the dilatation of cicatricial strictures in place of the ordinary rectal bougies. The bougies must be introduced with care, and too great force should never be used. The bougie is at first passed only into the stricture, not through it, the patient being, if necessary, under an anæsthetic. If too much force is used the rectum may be perforated. The bougies are introduced every two to four days, and one gradually passes to larger and larger sizes. Permanent success sometimes attends their use surprisingly soon. Division of the sphincter in the posterior rhapshe, so as to secure a painless introduction of the bougies, is seldom necessary. In some cases cocaine should be injected subcutaneously. Free movements must be secured during the treatment with bougies by means of cathartics or enemata.

2. Forcible dilatation by the use of special dilators, forceps, etc., is not without danger. The instruments are passed into the stricture when closed, and the latter is then dilated by opening their blades. Dilatation by means of the finger, which is cautiously bored into the stricture, is better than the use of instruments for the purpose.

3. Operative treatment of a stricture is often necessary if gradual dilatation does not accomplish the purpose. Incision with a knife is suited for strictures that are not too long. Care must be taken not to cut too deeply. If the stenosis is extreme, the stricture should be excised. We shall speak of the technique of these resections or partial excisions of the rectum when treating of extirpation of the rectum (see § 180, page 170).

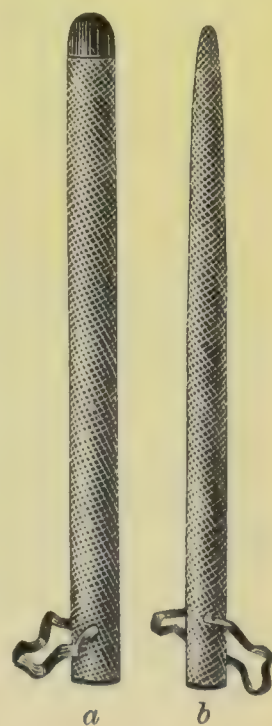


FIG. 469.—Two rectal bougies of different sizes: *a*, cylindrical; *b*, conical.

Cicatricial constrictions of the anal orifice are best divided in the anterior and posterior rhaps, and after extirpation of the cicatricial tissue the rectal mucous membrane is detached from the subjacent parts until it can be drawn far enough downward to be sutured to the skin. If the cicatricial mass extends too far into the rectum, so that there is not a sufficient amount of mucous membrane, the latter may be transplanted from elsewhere, after Wölfler, or two tongue-shaped cutaneous flaps are formed, one in front and one behind, after Dieffenbach, and the tips of the flaps are sutured into the posterior and anterior incisions in the rectum.

In all severe inoperable strictures of the rectum there still remains as a palliative operation the formation of an artificial anus (colostomy). One may then attempt to dilate the stricture by means of bougies, etc., and, if successful, close the artificial anus (see page 113).

§ 177. **Prolapse of the Rectum.**—The rectum is held in place by the periproctal cellular tissue, the fascia, and the muscles, especially at its lower end—viz., the levator ani, the recto-coccygei, and the sphincters. Stretching and loosening of these supports gives rise to prolapse of the rectum, either of its mucous membrane, especially the anal portion, or of the entire tube (see Fig. 470).



FIG. 470.—Extreme case of prolapse of the rectum (Van Buron).

As immediate causes of rectal prolapse are to be mentioned: Frequent straining during defecation, in consequence of chronic constipation; acute and chronic catarrhal inflammation of the rectum; hæmorrhoids; frequent childbearing; and diseases of the bladder (vesical stone), the urethra, and the prostate, with difficult urination. All these conditions, which are in part mechanical and in part inflammatory in their nature, produce a stretching and relaxation of the mucous membrane, or of the entire tube of the rectum, especially of the longitudinal fibres of the muscular coat (R. Fischl). Prolapse of the inflamed and swollen mucous membrane, caused by acute catarrhal inflammation, with œdema and swelling of the same, or by straining in connection with constipation and hæmorrhoids, is at first only temporary. From frequent recurrence of these predisposing causes, however, the prolapse gradually becomes more and more permanent. In most cases there is at first only a prolapse of the mucous membrane through the anal orifice, but in the worst cases the entire tube is prolapsed, as rep-

resented, for example, in Fig. 470. In such severe cases of long standing the reposition of the prolapse is easy to be sure, but it immediately recurs during defecation, coughing, or while walking, standing, or sitting. The size of the prolapse is very variable. It is sometimes as large as a child's head. In old prolapses the mucous membrane is dry and leathery, and ulcers are not infrequently formed. Incontinence of fæces ensues, especially in large prolapses, in consequence of stretching of the sphincter and insensibility of the mucous membrane. Strangulation of the prolapse sometimes occurs, and in rare cases a spontaneous cure from sloughing off of the lower part of the rectum. Children with catarrhal inflammation of the rectum and the colon, old men with chronic constipation, and women who have borne many children, are the chief victims of prolapse of the rectum.

It is of special importance that after long continuance of the prolapse the anterior fold of peritonæum between the rectum and the bladder, and in women between the vagina and the rectum, is drawn downward in the form of a hernial sac (Fig. 471, x). The small intestine,

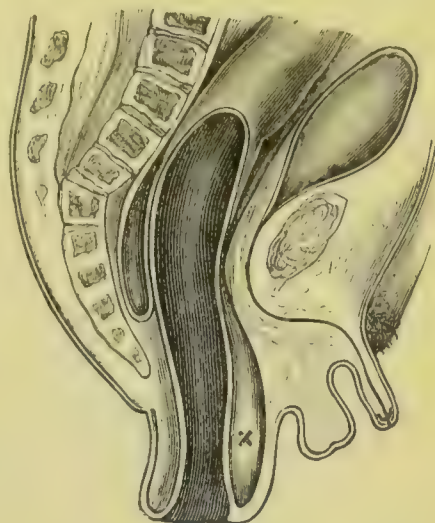


FIG. 471.—Rectal hernia (x) with prolapse of the rectum (diagrammatic section of the pelvis).

the ovary, and the bladder may occasionally be drawn into this rectal hernia, and in case of the intestine a so-called internal strangulation may arise. Owing to adhesions, particularly of the lower part of the hernial sac, reduction of the same may become impossible. Such herniæ of the rectum attending rectal prolapse are recognised by the unusually large tense swelling in the anterior portion of the prolapse. If the buttocks are elevated, the reduction of the hernia, which is attended by an audible gurgling sound from the small intestine lying within, can usually be accomplished, and one can then, as a rule, push back the prolapsed rectum without difficulty. In case of strangulation of the intestine lying in the hernial sac the usual symptoms of a strangulated hernia are observed—viz., a hard, painful inflammatory swelling in the anterior part of the prolapse, irreducibility of the hernia and the prolapse, and also symptoms of obstruction. If the strangulation is not promptly relieved, death ensues from perforation of the intestine and peritonitis. After gangrene of the strangulated portion of the intestine, a spontaneous cure may also result from the establishment of a communication between the intestine and the rectum—that is, an abnormal anus is formed which opens into the rectum.

Another form of rectal hernia arises from the bulging of the anterior wall of the rectum into the rectal cavity, in consequence, for example, of a perineal hernia developing in a backward direction. A retroverted uterus may enter this prolapse of the anterior rectal wall. The anterior wall of the rectum may also bulge into the vagina, so that the latter is forced out of the vulva (rectocele).

The prolapse of the invaginated colon from the anus is to be distinguished from prolapse of the rectum (see page 113). In severe cases the invaginated colon protrudes from the anus in the form of a long, sausage-shaped cylinder covered with dark-red hyperæmic mucous membrane (Fig. 472). This invagination of the colon is most frequently observed among children, but it occurs among adults also.



FIG. 472.—Prolapse of the invaginated colon in a boy ten years of age which was cured by resection.

It sometimes develops very suddenly and in other cases very gradually. It is characterized by the fact that one can push the finger high up into the rectum without striking a point of reflection of the mucous membrane. The invaginated colon lies free on

all sides in the rectum, and the finger can be swept around it. The conditions are altogether different in prolapse of the anus and rectum. In prolapse of the anal mucous membrane the finger comes at once upon its reflection, and in prolapse of the rectum the reflection is likewise easily felt lying in large prolapses directly above the sphincter.

Treatment of Prolapse of the Rectum.—By way of prophylaxis one should endeavour to prevent as far as possible the action of the above-mentioned predisposing causes—e. g., by regulating the action of the bowels or by curing diarrhœa or constipation. If the prolapse is slight, reduction is accomplished by pushing the prolapsed mucous membrane back with the finger covered with vaseline. Such cases are usually treated by the patients themselves or by the mothers of the children. Recurrences are best prevented by regulation of the bowels, by overcoming any diarrhœa or constipation, and also by cold douches and cold enemata. If reduction is not successful, the sphincter is stretched, with the patient under an anæsthetic, and reposition is then easily accomplished.

The retention of older prolapses is secured by means of special pads, or by the use of pedunculated, pear-shaped pessaries, which are introduced into the rectum. These forms of retention apparatus are usually not well borne. Esmarch recommends the use of a soft India-rubber ball, which is pressed against the anus by means of an elastic T-bandage. An elastic pad filled with air or an India-rubber ball is really the most serviceable thing. It is fastened to a pelvic girdle by a strap behind over the sacrum, and by two straps in front over the inguinal region. Esmarch and P. Vogt, among others, have constructed such retention apparatus (Fig. 473).

In all cases of prolapse of the rectum in which the affection increases and a retention apparatus is not well borne or is not sufficiently effective, there remains nothing but operative treatment. This should never be undertaken, however, without urgent reasons. The different methods of operating that have been recommended are the following:

In case of prolapse of the anus, one may diminish the size of the dilated anus by the formation of radiating cicatrices by excision of the skin and the mucous membrane with the knife, or by use of the thermo-cautery. The best way is to excise a large piece from the prolapsed anal mucous membrane, after Dieffenbach, and unite the edges of the latter by suture. The prolapsed mucous membrane may also be removed in the same way as hæmorrhoids—by use of the clamp and cautery.

In prolapse of the rectum ligation of the same is not to be recommended. The excision of spindle-shaped strips of the mucous membrane, or linear cauterization of the latter with the thermo-cautery, as in prolapse of the anus, is more advisable, though uncertain in its results. After suture of the wound or after contraction of the eschars, the diminished prolapse may be replaced and held back by a bandage. In case of prolapse of both the anus and the rectum, one may combine the methods above described.

Verneuil, Gérard-Marchant, Tricomi, and others recommend rectopexy in case of prolapse of the rectum. They expose its posterior wall by means of a longitudinal incision from the anus to the coccyx, and suture the rectum to the anterior wall of the sacrum or the coccyx without perforation of the mucous membrane. If necessary, one can diminish the size of the lower portion of the rectum or the anus by

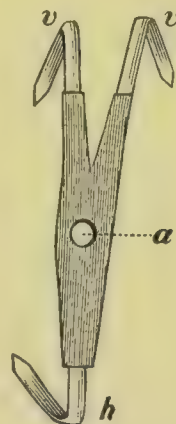


FIG. 473.—Apparatus for holding back a prolapse of the rectum: *a*, opening in the elastic inflatable pad for the anus; *h*, posterior strap; *v v*, the two anterior straps between the scrotum and thigh; the three straps are fastened to a pelvic belt.

means of a subcutaneous purse-string suture. The latter is sometimes sufficient in itself in prolapse of the rectum. The rectal orifice should be so reduced in size that only the little finger can be introduced. Another good plan in prolapse with incontinence of fæces is to detach the lower part of the rectum, twist it on its longitudinal axis so that the index finger can scarcely be passed through it, and suture it in this position.

In severe cases of prolapse of the rectum the removal or excision of the prolapsed portion is the best treatment. The operation is undertaken with the pelvis elevated and under an anæsthetic. One has the patient force the prolapse as far as possible out of the anus beforehand, and any intestinal loops that may lie in a rectal hernia are to be replaced before the operation. The prolapse is then made as bloodless as possible by massage and compression, and tied off at its base by means of an India-rubber tube. The prolapse is severed by layers about two centimetres from the elastic ligature. After ligation of the vessels that are visible, the edges of the serous membrane are united by continuous suture with catgut or fine silk, and then the muscular and the mucous coats, the latter not being pierced through its entire thickness, but simply caught up by the suture. The rectum is finally packed with iodoform gauze by inserting a rather large India-rubber tube enveloped in iodoform gauze and attached by a suture to the anus. Movements from the bowels are checked for six or eight days by the use of opium.

If a rectal hernia containing small intestine becomes strangulated, one should first attempt reduction of the hernia by taxis with elevated pelvis (see Hernia). If reduction of the strangulated hernia can not be effected, one will resort to an operation—that is, expose the orifice of the hernial sac, after dividing the covering of soft parts over the hernial tumour or in the rhapshe, open the hernial sac, and, after division of the ring, replace the intestine in case it is not already gangrenous (see particulars, § 185—Operation upon Strangulated Herniæ). If the ovary lies in a rectal hernia, its removal may become necessary on account of severe pain.

In case of prolapse of the invaginated colon from the anus, one will first attempt reduction with the patient completely under an anæsthetic and with elevated pelvis. Reduction is very difficult in extreme cases. In the case of adults, one may introduce the whole hand, after stretching the sphincter or dividing, it may be, the anal portion of the rectum in the posterior rhapshe, and try to push up the invaginated intestine higher and higher. For this reposition a rectal bougie or a tallow candle may be used. One can facilitate the reposition by allow-

ing lukewarm water to flow in through an irrigator. If reduction is unsuccessful, and there is danger in delay, laparotomy may be performed, and the attempt made from within the peritoneal cavity to bring the invaginated intestine into its normal place or to resect it. Resection of the large intestine is also indicated when the prolapsed bowel can no longer be reduced, on account of already existing or threatened gangrene. Mikulicz resected a portion of the large intestine, seventy-five centimetres in length, that had prolapsed from the anus, and then replaced what remained of the intestine. Nicolayson likewise removed in the same way a carcinoma of the sigmoid flexure that had become prolapsed through the anus by resection of the large intestine. Mikulicz, whose method I can warmly recommend from my own experience, operates as follows: After the anterior part of the circumference of the outer tube of the large intestine has been incised transversely two centimetres from the anal orifice, the serous coat of the outer tube is united with Lembert sutures to the serous coat of the inner tube. The remaining lateral and posterior portions of the outer tube are cut through transversely in the same way to a point near the protuberance of the invaginated mesocolon, which can be felt lying here, and the serous coat of the outer tube is sutured to that of the inner tube. The inner tube of the large intestine and the remainder of the outer one, with the mesocolon, are now divided, and, after the hæmorrhage has been arrested, the circular Lembert suture is completed. As in ordinary enterorrhaphy, so here, a double row of Lembert sutures is used. The stump of the prolapsed intestine is then replaced, and opium is administered in order that with fluid food movements from the bowels may be arrested for six or eight days.

Bogdanik, Boiffin, and others recommend, in place of resection, *colpexia abdominalis* in cases where the serous coat is not adherent or, in other words, the invagination of the colon is still reducible. This operation consists in opening the abdominal cavity on the left side, as in performing colostomy, reducing the invagination, and anchoring the colon by stitching the serous coat to the peritonæum.

§ 178. **Hæmorrhoids** (from *αἷμα*, blood, and *ῥέω*, to flow, because hæmorrhage is the principal symptom).—By hæmorrhoids is understood the varicose dilatation of the veins of the anus and the lower end of the rectum, in consequence of engorgement of these veins and of the portal system in connection with the most varied diseases of the same.

The causes of hæmorrhoids are to be sought in the manifold abnormal conditions by which the flow of the venous blood from the veins of the rectum and anus is impeded. Such causes are chiefly chronic constipa-

tion or the pressure of solid faecal masses accumulated in the rectum, catarrhal inflammation of the rectum, also the irritation of the intestine by the frequent use of strong cathartics, the pressure of tumours of the uterus, the ovaries, the bladder and prostate, changes in position of the uterus, pregnancy, diseases of the liver and the spleen, circulatory disturbances attending diseases of the heart and lungs, employments that require prolonged standing or sitting, etc. The tendency to hæmorrhoids seems often to have been inherited.

Hæmorrhoids are most frequently observed among men in middle life, and especially in the higher classes with sedentary pursuits and luxurious habits, less frequently among the common labouring classes.

The symptoms of hæmorrhoids at the beginning of the affection are a feeling of fulness and weight, and itching or pain in the rectum. After a movement of the bowels the patient usually feels better. Hæmorrhages occur from time to time and are a prominent symptom. They are conditioned upon rupture of the dilated veins of the rectum in consequence of increasing engorgement, and they are not infrequently very profuse. The patient feels relieved after the hæmorrhages, and hence the mistaken notion that this is an affection that contributes to the health of the patient, and accordingly should not receive treatment. The anæmia following these hæmorrhages may be extreme, especially among young girls who too often conceal the trouble from a sense of modesty. I know an opera singer who loses at times immense quantities of blood, but he nevertheless can not be persuaded to undergo an operation.

In advanced cases of hæmorrhoids there are found large external and internal bunches of dilated veins, sometimes as large as the fist, protruding from the anus. Engorgement of blood in the tumours sometimes causes rupture of the walls of the vessels with corresponding hæmorrhage, and sometimes cessation of the blood current with coagulation of the blood. A sort of spontaneous cure may result from the latter, but only in places. The trouble as such remains. The external tumours sometimes become strangulated, causing severe pain and striking disturbance of the general health. If the strangulation is not relieved, the piles become gangrenous and are cast off. Death even may result from pyæmic and septic processes. Inflammations of the greatest variety are comparatively frequent in connection with hæmorrhoids, sometimes amounting to suppuration of the tumours in consequence of suppurative thrombo-phlebitis. Periproctal abscesses, fistulæ and fissures of the rectum, etc., are also frequently observed. The increased secretion of mucus which often exists in consequence of chronic catarrhal proctitis is very troublesome also, as is the pro-

lapse of the mucous membrane of the rectum attending the least exertion of abdominal pressure, which constantly increases in amount.

Treatment of Hæmorrhoids.—In treating hæmorrhoids, an effort should be made to ascertain their cause in each case, and to regulate the habits of the patient accordingly. If the cause of the affection can be removed, even large hæmorrhoidal tumours may disappear, as has been frequently observed to be the case after pregnancy, for instance.

As regards the affection itself, one must first of all regulate the action of the bowels by enemata, less by cathartics. Treatment from time to time in Carlsbad, Marienbad, Kissingen, etc., is to be strongly recommended. The strictest cleanliness should be maintained by frequent baths and cold douches, especially when external piles are present. The latter should be protected from friction by inserting cotton or boric lint. Inflamed piles are to be treated according to general rules. If they become prolapsed and strangulated they should be replaced, as in prolapse of the anus and the rectum, with the patient under an anæsthetic, if necessary, and after stretching the sphincter. One can often permanently overcome the disturbances attending hæmorrhoids by stretching the sphincter. Gangrenous piles are removed by means of the thermo-cautery.

Aside from this purely symptomatic treatment, the best course is to remove the hæmorrhoids altogether. Mild cases can be cured by the injection of pure carbolic acid (equal parts with glycerin, or one part carbolic to two or three parts glycerin). Two to three drops are sufficient, or, if the pile is large, five or six drops should be used. The injection may be made upon five or six separate piles at a single sitting. An anæsthetic is unnecessary, but the use of cocaine and a suppository is to be recommended. This method of treatment is usually painless and sure, and allows the patient to attend to his business. One must take care, when injecting the pure carbolic acid by means of a hypodermic syringe, that the mucous membrane in the vicinity is not cauterized by any acid that may escape through the puncture opening. The injection may have to be repeated in from two to three weeks. The after-treatment consists mainly in giving fluid food. I no longer prescribe opium, but prefer to make use of enemata. Only rarely is it necessary for the patient to remain two or three days in bed.

If it is desired to destroy the hæmorrhoidal tumours by use of the thermo-cautery or by excision with the patient under an anæsthetic, internal piles must be made sufficiently accessible by stretching the sphincter and the introduction of a Simon or Sims vaginal speculum. The separate piles are then drawn downward by means of a suitable forceps—e. g., that represented in Fig. 474—and seized with a clamp

(Fig. 475, *a* and *b*). The surroundings of the pile are protected by this clamp from the action of the cautery. The vicinity of the pile may, in spite of this, easily be burned, and it is therefore well to protect it further by moist gauze. The pile thus seized with the clamp is then gradually burned to a crisp. The thermo-cautery should not be too hot, for if the carbonization is too rapid, secondary hæmorrhages easily ensue, which may be dangerous, especially when inside the rectum. In



FIG. 474.—Luer's forceps for seizing hæmorrhoids.

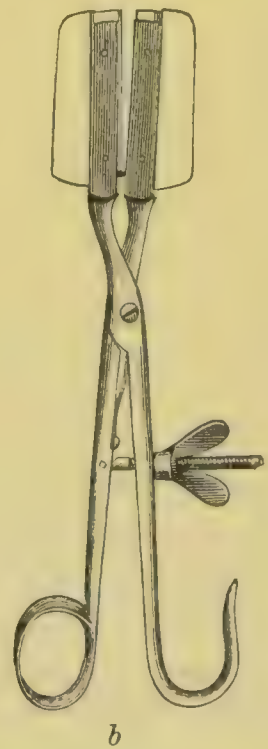
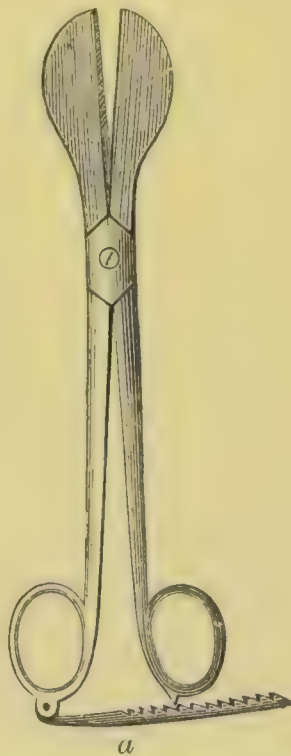


FIG. 475.—Clamps used in the cauterization of hæmorrhoids: *a*, Langenbeck's; *b*, Smith's.

order to make sure of no secondary hæmorrhages, I usually tie off the pile with catgut before applying the cautery. Larger vessels are ligated separately. One may also use the galvano-caustic loop in place of the thermo-cautery.

Excision of hæmorrhoids is also a very good operation. The mucous membrane is then united with the outer skin by a continuous catgut suture.

In any operation for hæmorrhoids care must be taken that enough of the mucous membrane or skin of the anus is retained, as otherwise troublesome cicatricial contraction of the same may arise. In order to prevent subsequent painful contractions of the sphincter, division of the same is frequently resorted to after the operation.

The after-treatment following an operation upon hæmorrhoids consists in giving fluid food and opium. In case of pain, ice compresses and hypodermic injections of morphine are employed. One should be

on his guard against secondary hæmorrhages. Should they occur, the rectum is to be sufficiently exposed by stretching the sphincter and introducing a vaginal speculum with the patient under an anæsthetic, and the hæmorrhage arrested by ligatures. The first passage from the bowels, five or six days after the operation, should be facilitated by cathartics and enemata.

§ 179. **Tumours of the Anus and the Rectum.**—Among benign new growths papillomata occur sometimes in large numbers, and may reach a considerable size. Esmarch saw a papilloma of the anus as large as a duck's egg. These papillomata frequently resemble broad condylomata. Soft fibromata, angiomas, sebaceous cysts, and especially carcinomata, also occur about the anus.

In the rectum itself there are found, among benign tumours, myomata, lipomata, and fibromata. Fibromata are either single or multiple. They present roundish, lobular, sessile, or more pedunculated tumours. The so-called rectal polyps are in part fibromata and in part proliferations of mucous membrane or hypertrophies of the glandular elements. Polyps of the rectum sometimes occur in large numbers. Langenbeck, Th. Smith, and A. Bickersteth observed multiple polyps of the rectum in a mother and child. Large polyps may be drawn more and more downward, and thus cause an invagination of the rectum. The pedicle of the polyp is sometimes torn off, and the tumour is evacuated with the fæces. All tumours which have attained an appreciable size give rise chiefly to a corresponding stenosis of the bowel. Sarcomata also occur in the rectum, partly as sessile and partly likewise as pedunculated tumours. Even benign tumours of the rectum—e. g., myomata and fibromata—sometimes perforate the peritoneal cavity, and may then be mistaken chiefly for ovarian tumours.

The most important and the most frequent new growth of the anus and the rectum is the carcinoma. The carcinoma forms at the anus or in the rectum, in part sharply circumscribed nodules and in part more diffuse papillary growths, at a definite part of the wall, or involving the whole circumference of the gut. It is characteristic of carcinoma, especially that of the rectum, that it feels infiltrated at an early stage. Ulceration then soon follows, and the ulcers have a hard base and infiltrated edges. The wall of the intestine is more or less contracted.

Cancer of the rectum is usually, histologically, a glandular carcinoma with cylindrical cells. Proliferation of the glandular ducts gives rise at the outset to an adenoma, which then, by atypical growth of the epithelial cell elements, becomes a carcinoma. The destructive adenomata also have the same clinical course as genuine carcinomata. The glandular type is no longer demonstrable in the later stages of the

carcinoma. Glandular ducts with cylindrical epithelium are only found at the periphery of the tumour.

In addition to this adeno-carcinoma, there also occur scirrhus, carcinoma simplex, and especially colloid carcinoma. The latter sometimes forms very large gray, gelatinous growths. The epithelioma of the outer skin of the anus is composed of squamous cells, while that of the mucous membrane is made up of cylindrical cells.

Carcinoma of the rectum very soon causes gradual stenosis. The rectum is usually dilated above the stricture, in consequence of the faecal masses that are retained here. The mucous membrane can furthermore come together in the form of a valve in such a way as to render the rectum completely impassable. In the further course of a carcinoma of the rectum the cancerous infiltration of the organ increases constantly in extent and depth, the tumour becomes adherent to the neighbouring organs, and it perforates, in consequence of the ulceration, the bladder, the prostate, the vagina, or the uterus, or, in other cases, a sacculated, periproctitic sloughing abscess is formed, which not infrequently ruptures into the peritoneal cavity, and leads to general septic peritonitis. Secondary carcinoma nodules are found, especially in the lymph glands of the hollow of the sacrum and also in the liver, in consequence of the transportation of carcinoma cells through the portal circulation.

As characteristics of carcinoma, clinically considered, we have especially the symptoms of stenosis, the discharge of blood and pus in consequence of the ulceration, the above-described characteristic condition found in the rectum, and increasing cachexia. In the later stages the patient suffers greatly, as a rule, from the increasing stenosis and ulceration, and particularly after the carcinoma has broken through into the surroundings of the rectum.

The prognosis of carcinoma of the rectum is, like that of all carcinomata, unfavourable. If operative measures are not taken, death usually ensues in from one to two years, seldom later. By early extirpation of the carcinoma, however, a permanent cure is possible, and the results following extirpation of the rectum for this disease are, so far as permanence of the cure is concerned, more favourable than those, for example, following amputation of the breast for carcinoma. According to the statistics of Henck, Hildebrand, Fischer, Sihle, Cripps, and Ekehorn, there is a recurrence in about sixty per cent of the cases after extirpation, usually within the first year.

The diagnosis of carcinoma of the rectum can only be made with certainty when the new growth can be felt by introducing the finger. One then feels sometimes a soft and sometimes a harder nodular tumour, or, in still other cases, a more diffuse fungous growth or cleft ulcer with a hard base and indurated edges. Carcinomatous ulcers are most likely to be mistaken for syphilitic ulcerations. In doubtful cases, therefore, parts of the new growth

should be removed for microscopic examination. It is characteristic of syphilitic affections, as is well known, that they undergo striking improvement under a general antisyphilitic treatment, especially from the use of iodide of potassium.

Treatment of Tumours of the Anus and Rectum.—Polyps of the rectum are best removed by excision after tying off the pedicle. Simply cutting them away without ligation of the pedicle is not a good procedure, as dangerous secondary hæmorrhage into the interior of the rectum may occur from so doing. In suitable cases they may be removed by the use of the thermo-cautery or the galvano-caustic loop. Other tumours of the anus and the rectum are extirpated in accordance with general rules. Tumours that are situated high up in the bowel should be made sufficiently accessible by stretching the sphincter and introducing a Simon vaginal speculum. Senn removed by laparotomy a myofibroma of the rectum, weighing twelve pounds, which was situated within the peritoneal cavity. Benign tumours of the rectum, such as polyps, for example, should always be removed, as they occasionally change into carcinomata. Sarcomata of the anus and the rectum are operated upon in the same way as carcinomata. Both varieties of tumours should be promptly and thoroughly extirpated, as the fact has been sufficiently established that a permanent cure is possible in this way. All palliative operations, such as scraping and cauterization with the thermo-cautery, are without avail. A permanent cure is possible only by excision of a portion of the rectum. Carcinoma of the rectum is, judging from my experience, one of the most favourable forms of cancer, and a large number of permanent cures has already been observed after proper operative measures. The technique of extirpation of carcinomata of the rectum has been much improved of late, and the risk of life attending it has been greatly reduced. Czerny lost but one case out of twenty-five that were operated upon, and Bergmann also has similar results to show. I had eleven successful cases of extirpation of the rectum with resection of the sacrum. Death followed in one case, not in consequence of the operation, but from a periproctitic abscess that ruptured into the peritoneal cavity. The abscess already existed before the operation, and had arisen from an old perforation of the rectum above the stricture.

The improvement in the technique of extirpation of the rectum consists chiefly in facilitating access to the field of operation by resection of the sacrum, especially in carcinomata that are situated high up, and in packing the wound with iodoform gauze, which permits free drainage. It was formerly a rule that only those carcinomata should

be operated upon whose upper boundary could be reached with the finger. This rule exists no longer. It is not the height of the carcinoma which decides whether we shall operate or not, but only the degree of its adhesion with the surrounding parts. If, upon examination under an anæsthetic, I find that a carcinoma situated high up is no longer movable—that it is firmly adherent with its surroundings—I then decide against its extirpation. In inoperable cases of carcinoma of the rectum with the stenosis high up in the bowel, colostomy may be performed, in order to make defecation possible through an artificial anus. One may also divide the sigmoid flexure, suture its upper end into the abdominal wound, forming an artificial anus, but close the rectal end by a double row of sutures, and drop it back into the abdominal cavity. In this way the pain is lessened, because the irritation of the fæcal masses in the rectum is prevented.

We shall take up the technique of resection and excision of the rectum more in detail in the section that follows.

§ 180. **Excision of the Rectum.**—Excision of the rectum is performed chiefly for carcinoma, also for extensive ulceration and syphilitic or traumatic strictures which can not be cured by dilatation. A distinction is made between partial excision or resection of the rectum and its complete extirpation. Some surgeons perform inguinal colostomy about ten days before the operation, in order to stop temporarily the passage of fæces through the rectum.

The preparation of the patient for the operation consists in giving fluid food for two days beforehand, and in thorough evacuation of the intestinal canal by cathartics and by irrigation of the rectum, the latter being repeated two hours previous to the operation. Fifteen to twenty drops of tincture of opium are given just before the operation. The anal region is shaved and carefully disinfected, and the surface of sloughing carcinomata is scraped away and rubbed with pledgets moistened in a from five- to ten-per-cent solution of chloride of zinc. The patient lies in the lithotomy position with the pelvis elevated. The partial excisions of the rectum which were formerly in vogue, with subsequent suture and drainage, are not advisable for carcinoma. It is here of prime importance that a sufficiently large piece be extirpated from the continuity of the rectum, with or without preservation of the anus or the sphincter. We are under special obligations to Kocher, Kraske, and Bardenheuer for the technique of extirpation of the rectum.

Tumours of the anus are easily excised. The tumour is drawn downward for a sufficient distance by means of forceps and removed. The wound is sutured in a transverse direction in order to prevent a

stricture. The anus usually has to be stretched in order to allow the introduction of a speculum, and thus make the tumour accessible. If the entire anus is to be excised, this is best done by making a circular incision around it, dissecting up the rectum, dividing the latter transversely through sound tissue, and suturing it to the edge of the skin near the anus by silk stitches. Only a few sutures should be inserted, in order that strips of iodoform gauze may be introduced here and there between them.

If a large portion of the rectum, with or without the sphincter or the anus, requires removal, e. g., for a carcinoma situated high up, the best plan is to adopt the method of Kocher, Kraske, or Bardenheuer—that is, to make an incision in the poster rhapshe as far as the middle of the sacrum, and resect the coccyx (Kocher) or a part of the sacrum as well

(Kraske, Bardenheuer). Kraske removes a part of the left half of the sacrum, and Bardenheuer divides the lower part of the sacrum transversely (see Fig. 476).

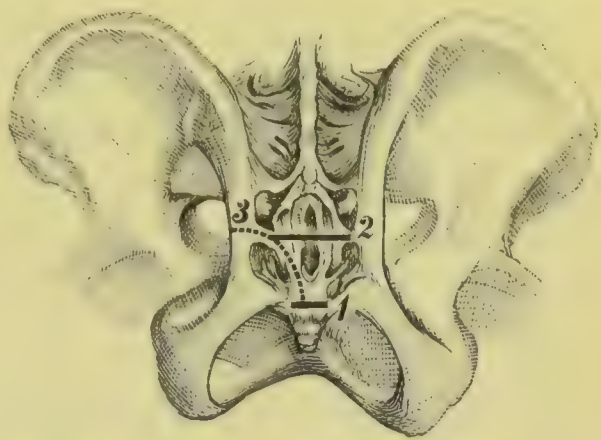


FIG. 476.—Excision of the rectum: 1. with extirpation of the coccyx; 2. with transverse resection of the lower portion of the sacrum after Bardenheuer; and 3. with resection of the left border of the sacrum after Kraske (diagrammatic).

Excision of the rectum by a posterior longitudinal incision, after Velpeau, Simon, and Kocher, is performed as follows: The skin incision is made from the anus to the tip of the coccyx, in case the carcinoma does not extend too far upward, and can easily be drawn downward below the tip of the coccyx after division of the posterior rectal fascia and the muscles. If the latter is not the case, the coccyx is laid bare, by continuing the skin division to the sacrum, and extirpated, as was first recommended by Kocher. Extirpation of the coccyx is also strongly to be recommended even in cases where the carcinoma is situated low down, on account of the greater accessibility of the field of operation which is thus secured, and the better discharge of the secretions of the wound during the after-treatment. After the posterior wall of the rectum has been exposed, it is divided from the anus upward to a point above the carcinoma, and the rectum is then transversely severed below the tumour. The diseased part is then detached all around, partly with the fingers by blunt dissection, and partly with curved scissors, and the reflection of the peritonæum is pushed upward posteriorly, and especially in front, where it extends lower down.

The sound part of the rectum is secured above the upper limit of the carcinoma by means of one or two long sutures in order that it may not retract, and the rectum is then again severed transversely above the tumour. The upper part of the intestine is now drawn downward and attached by a circular continuous catgut suture to the anal end of the same. If the tension upon the upper end is too great, only a few tension stitches are inserted and the longitudinal incision in the anal portion is left open. I never suture the external wound, but pack it with iodoform gauze, which should be pushed up into the hollow of the sacrum and in front of the rectum. I use but very little iodoform gauze: in one case, of very extensive extirpation of the rectum, I saw temporary iodoform poisoning (marked restlessness, delirium, mania) after packing the wound with iodoform gauze, which gradually subsided after immediate removal of the gauze.

If it is desirable to remove the anus at the same time, a circular incision about the anal orifice, after Lisfranc, is made, in addition to the posterior longitudinal incision. The detachment of the rectum, especially in case its anterior diseased wall is adherent, can be facilitated by making an anterior longitudinal incision along the rhapshe of the perinæum. The rectum is now separated *in toto* on all sides, both from the anal region and along the posterior longitudinal incision, in part by blunt dissection with the fingers and in part with curved scissors, but not divided by longitudinal incision of its posterior wall. In other respects the operation is performed in the same manner as described above.

Kraske's Extirpation of the Rectum, which involves chiselling away the left border of the sacrum, is especially adapted for carcinomata, which have a very high location and are extensive. The patient lies at first upon the right side. The skin incision in the posterior rhapshe begins near the anus and ends at about the middle of the sacrum. One then cuts down upon the rectum, exposes the edge of the sacrum on the left side, excises the coccyx, and divides on both sides the attachments of the sacro-sciatic ligaments. The outer edge of the wound is now well retracted, and a portion of the left border of the sacrum is resected with a chisel (Fig. 476, 3). The line of division of the sacrum is curved. It begins on a level with the third posterior sacral foramen, and then runs inward and downward in a curve, with its concavity to the left, past the lower border of the third sacral foramen and through the fourth as far as the left cornu of the sacrum. In this way no nerves are injured, the anterior branch of the third sacral nerve is spared, and the sacral canal is not opened. The rest of the operation is performed with the patient in a

dorsal position, with elevated buttocks, as in the methods of Bardenheuer and Kocher. After dividing the posterior wall of the rectum in a longitudinal direction, the access to its upper part is now so free that one can easily amputate it, under constant guidance of the eye, at the point of transition into the sigmoid flexure, or resect it in continuity with preservation of the anal portion. It is better, in the latter case, not to divide the lower, sound part of the rectum. After the extirpation is completed, the upper end of the intestine is drawn down into the wound or united with the anterior circumference of the lower end by a few tension sutures. If the lower part of the rectum is divided longitudinally behind, this open part of the rectum is closed, not by suture, but by a later plastic operation (by means of double flaps from the skin on both sides). If the anal portion is preserved and has not been divided posteriorly, the two ends of the intestine may be united by circular enterorrhaphy, or sutured only at their anterior circumference. As for the rest, the wound remains open and is packed with iodoform gauze, as described above, after the hæmorrhage has been carefully arrested. In all cases in which it is possible, the upper end of the intestine should be united with the lower end. E. Boeckel recommends covering the sutured rectum with a skin-flap for the sake of avoiding gangrene, etc. Hochenegg drew the upper end of the intestine through the lower anal end, and then secured it with sutures. This method of invagination may be followed by serious stenosis. Hochenegg modified Kraske's method as follows: Instead of placing the patient as described above, and as recommended by Kraske, Hochenegg has him lie during the whole operation on the left side with his legs flexed at the hip and knee and drawn up against the body. He recommends a curved incision, with its convexity to the right, running from the middle of the left sacro-iliac synchondrosis over the median line as far as the right edge of the coccyx. If the anus is also to be removed, a proper incision is made about it in addition. In the resection of the sacrum, Hochenegg takes a middle course between the lateral and the transverse method, whereby more room is gained.

Excision of the rectum with transverse resection of the sacrum, after Bardenheuer, is also an excellent method. The patient lies in the lithotomy position with elevated buttocks. The skin incision runs in the posterior rhapshe from the anus to the middle of the sacrum. If the anal portion of the rectum is likewise to be removed, a circular incision is made about it, and, if desirable, a longitudinal incision in the anterior rhapshe is added. The coccyx and the edges of the sacrum are now exposed, the sacro-sciatic ligaments are severed on both sides close to the bone, the coccyx is seized with bone forceps, drawn back-

ward, and removed, and the sacrum is excised with a bone-cutting forceps as high as possible, according to the extent of the carcinoma, even in the neighbourhood of the third sacral foramen, so that one may pass the whole hand into the pelvic cavity. The rectum is now exposed from behind by a few longitudinal cuts, and then detached by blunt dissection with the finger and by curved scissors, the index finger being introduced as a guide and for the purpose of drawing the rectum backward. By thus drawing the rectum away from the bladder and the urethra, injury of the ureter, the urethra, and the vagina is best avoided. The hæmorrhage attending this blunt method of operating is very slight. In detaching the rectum one must constantly keep close to its wall, as the operation is otherwise rendered unnecessarily difficult and is also more bloody. If the rectum has been freed on all sides, and if the anal portion is to be preserved, a silk ligature is passed about the rectum, and the latter severed with scissors below the ligature. The blunt detachment of the rectum in an upward direction is then continued, as necessity may require, and the reflection of the peritonæum is carefully pushed upward. Should the peritonæum be torn and the intestine prolapse, the latter should be thoroughly disinfected, and the tear in the peritonæum closed with catgut. If the vagina is opened, it should also be sutured. Finally, the rectum is divided transversely above the carcinoma, after it has been detached, so far in an upward direction that the upper end can be easily sutured to the anal region of the wound, or to the lower anal portion of the rectum which has been preserved. The upper end of the rectum is attached below, in extirpation of both the rectum and the anus, merely by a few tension stitches. In case of resection in continuity the upper and lower ends of the rectum are united by means of two rows of catgut sutures, first through the muscular and serous coats, and then through the mucous membrane. I have frequently found it a good plan to divide the sphincter posteriorly and leave it open.

If the carcinoma extends into the sigmoid flexure, Bardenheuer recommends separating the lower part of the rectum in the manner just described, and then completing the detachment through an extra-peritoneal incision along Poupart's ligament. This incision runs from the symphysis, along Poupart's ligament as far as the anterior superior spine, and goes down to the peritonæum without opening the latter. The sigmoid flexure is made sufficiently movable through this incision to allow it to be drawn downward and sutured into the wound.

Of the methods that have been mentioned, those of Kraske and Bardenheuer are very useful, as well for amputation of the rectum as

for its resection in continuity, especially in treating carcinomata with a high location. For those that are situated lower down, Kocher's method suffices. In inoperable cases an artificial anus should be made as soon as the stenosis becomes extreme, unless the stricture can be overcome by scraping and the use of Paquelin's cautery.

Of other methods of extirpation of the rectum with and without preservation of the anal portion, I mention the following: Hueter formed a musculo-cutaneous perineal flap by means of a horseshoe incision open toward the anus. The flap contained the skin, the sphincter, the anal orifice, and the lowest part of the rectum. The curved portion of the horseshoe incision lies close below the posterior insertion of the scrotum, and the two sides of the incision run along the outer edge of the external sphincter. The flap is detached and reflected backward and downward. The rectum is then exposed, and, after resection of the diseased portion, the upper end is attached to the anal portion by suture. The sphincters remain wholly intact. Zuckerkandl has recently recommended exposing by a similar incision the prostate, the posterior wall of the bladder, and the rectum (see *Surgery of the Male Genito-urinary Organs*).

Dieffenbach and Volkmann performed resection of the rectum in continuity with preservation of the sphincter in the following manner: The anal orifice was divided by a posterior incision as far as the coccyx, and an anterior incision in the rhaphe of the perinæum. The ends of the incisions lying in the rectum extended to the vicinity of the diseased part, and were united on both sides by transverse incisions, so that the healthy lower part of the rectum was separated from the diseased part. The latter was then detached, and the upper sound part secured by one or two loops of silk. The part containing the tumour was severed below the loops of thread, and, after the hæmorrhage had been arrested, the upper end of the intestine was united by suture with the anal portion. Then followed suture of the anterior and posterior superficial wounds and drainage of the same.

Rehn proposed making two stages out of Kraske's operation: First, resection of the sacrum and detachment of the diseased part of the intestine, which is brought up into the wound and retained by means of a strip of iodoform gauze; second, about ten days later, circular suture of the intestine and suture of the wound.

Heineke recommended temporary transverse resection of the sacrum, the flap of skin and bone being reflected downward and to the right. The posterior incision in the rhaphe extends to the tip of the coccyx, and the rectum is divided transversely at this point. An oblique incision is then made upward along the left edge of the sacrum, and finally a transverse one across the sacrum. To protect the nerves during the transverse division of the sacrum, they may be exposed beforehand, after Kocher, in the vertebral canal.

W. Levy recommends modifying Heineke's method in such a way as to leave the pelvic floor and the sphincter intact. The skin incision, eight or ten centimetres long, runs transversely across the sacrum a finger's breadth above the cornua of the coccyx. From each end a perpendicular incision eight centimetres long is made downward through the skin and the

glutæus maximus muscle. The flap of soft parts and bone is reflected downward. As the inferior hæmorrhoidal nerves are severed in the lateral incisions, causing paralysis of the sphincter (Arnd), which, to be sure, is preserved, it is better to make these incisions only through the skin below, and then gradually to deepen them above, so that the lower fibres of the glutæus muscle and the sacro-sciatic ligaments, which are attached to the sacrum, are severed close to the bone.

Hegar uses a V-shaped incision upon the dorsal surface of the sacrum with its base above. The sides of the V begin one centimetre below the posterior inferior spinous processes of the ilium, and meet at the tip of the coccyx. The sacrum is sawn through transversely, with preservation of the periosteum on its anterior surface. The sacrum is then reflected upward.

Rehn and Rydygier performed temporary resection of the sacrum as follows: A skin incision is made on the left side of the sacrum one centimetre from the edge of the bone, beginning below the posterior superior spinous process of the ilium, and extending to a point beyond the tip of the coccyx, and further downward, as necessity may require. A transverse incision is made below the third sacral foramen—that is, two finger breadths above the junction of the coccyx and the sacrum—and the sacrum is divided along this incision with hammer and chisel.

Gussenbauer divides the sacrum transversely above and longitudinally in the middle, and reflects the two halves to either side.

All the methods of temporary resection that have been mentioned are also suited for making the other pelvic organs, especially the uterus, accessible for operations.

The incontinence of fæces following excision of the rectum, inguinal colostomy, etc., can be prevented or overcome by twisting the end of the intestine on its long axis and suturing it in this position (Gersuny). Good results have also been secured by flexing the intestine at an angle over the edge of the sacrum, or giving it an oblique course through the soft parts. Willems, Witzel, and Rydygier bring the upper end of the rectum obliquely through a slit in the pyriformis and glutæus magnus muscles, and suture it here within the external wound in the left buttock (see also page 131).

CHAPTER XXI.

HERNIA.

General remarks upon the anatomy, etiology, and occurrence of hernia.—Symptomatology, clinical course, and complications.—Reducible and irreducible hernia.—Strangulated hernia.—Prognosis, diagnosis, and general treatment of reducible hernia.—General remarks upon trusses.—Treatment of strangulated hernia.—Taxis.—Herniotomy.—Radical operation for hernia.—Anatomy, symptomatology, and treatment of the separate forms of hernia.—Umbilical hernia.—Ventral and lumbar hernia.—Inguinal hernia.—Femoral hernia.—Obturator hernia.—Ischiatic hernia.—Perineal hernia.—Rectocele.—Colpocoele.—Internal herniæ.—Diaphragmatic, intraperitoneal, and retroperitoneal herniæ.

§ 181. General Remarks upon the Anatomy and Etiology of Hernia.

—By a hernia (from *ἔρπος*, a branch, an outgrowth) or rupture is understood the protrusion of some abdominal organ, most frequently the intestine, from the peritoneal cavity through a normal or abnormal opening in the abdominal wall, and in such a way that the organ involved is provided with a complete or incomplete covering of peritonæum. A hernia that protrudes externally and comes to lie beneath the outer coverings is called an external hernia—e. g., umbilical, inguinal, femoral hernia, etc; while one that remains in the peritoneal cavity—e. g., one lying in a pouch of the peritonæum—is called an internal hernia. To the latter class belong especially the intraperitoneal and retroperitoneal herniæ, the diaphragmatic herniæ, and the protrusions into the vagina or the rectum. A hernia consists of the following parts:

1. The hernial ring, through which the hernia protrudes from the abdominal cavity. The opening in question may be either a normal or an abnormal one, arising, for example, from an injury. The different herniæ are designated according to the location of this opening—e. g., inguinal hernia, femoral hernia, umbilical hernia, diaphragmatic hernia, etc.

2. The hernial sac—that is, the part of the parietal peritonæum which is pushed outward by the viscus that protrudes from the peritoneal cavity. The upper part of the sac, which is most constricted and lies within the ring, is called the neck of the sac, and through this the sac communicates with the peritoneal cavity. The hernial sac may be absent—e. g., in a hernia which has protruded through a rent in the peritonæum, or when a sac that

existed at first has ruptured. A partial absence of the sac is observed when the extraperitoneal portion of an organ protrudes through the hernial opening—e. g., in hernia of the cæcum, which often has no peritoneal covering on its posterior and inferior surfaces. The posterior surface of the protruding cæcum is then usually adherent to the hernial sac, and we have to do, as it were, with a partial enterocele, with a so-called Littré's hernia, in which only a portion of the intestinal wall, not the whole intestine, has protruded (see page 186, Fig. 480). The hernial sac is sometimes apparently absent—when, for example, in persons with very little fat, the sac and its coverings are abnormally thin and adherent to the subcutaneous fascia. Great caution is necessary in operating upon herniæ with apparent or real absence of the sac not to cut into the intestine in place of the supposed hernial sac.

The form of the hernial sac varies with the anatomical character of the part involved. It is sometimes bottle-shaped or pear-shaped, or it may be cylindrical or constricted at several points. There are sometimes two or more sacs in one hernia. They lie beside each other or above one another, and they are sometimes pushed into one another. One sac sometimes rests like an appendage or a diverticulum upon the other. The appearance of a double hernial sac may also be given by cyst formation in the tissue of the hernial sac.

3. The coverings of the sac vary according to the location of the hernia. In external hernia we find, in addition to the skin and the subcutaneous cellular tissue, those layers which are continuous with the ones forming the hernial ring. Inasmuch, then, as the accessory coverings of the various herniæ differ greatly according to the location of the latter, we shall take them up more in detail when treating of the separate forms of hernia.

The contents of the sac consist most commonly of portions of the small intestine, and most frequently of its lower part, the ileum, more rarely of the duodenum and jejunum, which are less easily displaced from their normal position. Aside from the small intestine, the omentum also is often found in the sac, and it frequently forms the only contents of the same. Of the large intestine, the sigmoid flexure is most frequently found, especially in hernia on the left side, because it is very movable. The cæcum and the appendix are sometimes found alone in inguinal herniæ upon the right side; but in herniæ upon the left side they never occur alone, but always in combination with parts of the small intestine, which draw the cæcum into the sac (Linhart). Hildebrand has collected one hundred and twenty-eight cases of hernia containing the cæcum, of which one hundred were inguinal, eleven femoral, one abdominal, eleven umbilical, and one ischiatic. Among the one hundred inguinal herniæ, eighteen were left-sided and the remainder right-sided. In cases where the cæcum or the appendix lay in the hernial sac, typhlitis, perityphlitis, and appendicitis have been seen to occur within the sac (Brunner, O. Zuckerkandl, and others). Herniæ of the intestine are also called enteroceles; those of the omentum, epiploceles; and combinations of the two, entero-epiploceles. In rare cases portions of the bladder, the uterus, the ovary, a floating kidney, the ureter, etc., lie in the hernial sac, and the organs named are then frequently adherent to the latter. Herniæ containing the pregnant and non-pregnant uterus (hysteroceles) have been recently described in detail, especially by Brunner (Bruns, Beiträge zur klin. Chir., Bd.

iv). In case of very large herniæ with a wide ring—e. g., umbilical herniæ and large ventral herniæ—there is a sort of eventration—that is, a large part of the intestine, the stomach, the spleen, and a portion of the liver come to lie within the hernial sac.

The hernial sac is sometimes empty, especially when it is closed by adhesions at its ring, and in this way a sort of spontaneous cure has occurred. In such cases the hernial sac becomes usually a cyst filled with serous fluid.

Under certain pathological conditions—e. g., in consequence of venous stasis attending strangulation of the hernia—serous fluid collects in the hernial sac. Bloody fluid is found after contusions of the hernia, pus in connection with inflammations of the same, and intestinal contents after perforation of the intestine from gangrene of the same attending strangulation. In rare cases foreign bodies—e. g., pieces of bone that have been swallowed, fruit stones, etc.—have been found in herniæ.

The contents of the sac are either capable of reduction into the peritoneal cavity or incapable of reduction in consequence, for example, of adhesions between the sac and its contents, or of strangulation of the intestine.

Etiology of Herniæ.—There have been various theories regarding the etiology of herniæ. In congenital herniæ we have primarily to do with a malformation or abnormality in the development of the involved part of the abdominal wall. In acquired herniæ various factors have to be considered. The intra-abdominal pressure exerted upon parts of the abdominal wall which are less capable of resistance plays an especially important part. We shall see, when treating of the various forms of herniæ, that certain parts of the abdominal wall, in consequence of their diminished resistance, are predisposed to the development of hernia. The following conditions are also of importance in connection with their development: Abnormal length and relaxation of the mesentery, as well as a low position of its insertion (Lockwood); and, finally, abundant fat in the subperitoneal cellular tissue of the parietal peritonæum, which by its growth externally drags the peritonæum after it in the form of a pouch (Roser). This outward traction, caused by subperitoneal lipomata, is probably a rare factor. The anatomical character of certain parts of the abdominal wall is of great importance in the origin of a hernia, especially normal or abnormal openings—e. g., the inguinal and the femoral canals; also defective closure of the peritoneal cavity, a diminished resistance of the abdominal wall, and cicatrices after wounds, after operations, etc. In addition to this anatomical predisposition, there is an exciting cause which sometimes acts suddenly and sometimes gradually in the production of a hernia. We seek this determining cause chiefly in the greater or less increase of intra-abdominal pressure—e. g., from the constant lifting of heavy burdens, from frequent coughing, singing, screaming, blowing, or pressing, or in connection with chronic constipation, etc. Hernia is accordingly to some extent an occupation disease. The parietal peritonæum yields more and more to the increased intra-abdominal pressure at the weak place in the abdominal wall, and a protrusion is formed here, into which the viscera gradually pass. In some cases the abdominal viscera are forced suddenly into a preformed hernial sac, under the influence of an exciting cause. In other cases displacement of the abdominal organs occurs suddenly from an injury of the abdominal wall or from a rent in the peritonæum or the dia-

phragm. These traumatic herniæ are not true herniæ, inasmuch as they possess no hernial sac. The hernial sac—that is, the true hernia—is always developed gradually, though an injury may, of course, act the part of the exciting cause. The supposed sudden development of a true hernia is, in my opinion, always dependent upon a mistake in observation. The hernial sac, as a rule, is already present, but is empty, or the hernia already formed at the time of the injury was so small as not to have been noticed. I therefore agree with Socin that a hernia, from the medico-legal point of view, is not to be designated exclusively as an “injury.” The herniæ supposed to have arisen “suddenly in consequence of an injury” are in part a result of the traumatism, but are due in part to a special condition of the body of the injured person which already existed.

According to Malgaigne, there is one ruptured person to about twenty or thirty sound ones. Owing to the nature of their employment, hernia is about four times as common among men as among women. The frequency of hernia is, according to Wernher, somewhat less than estimated by Malgaigne. He judges that there is one case of hernia to every forty to sixty persons. Inguinal hernia is the most common, and then follow in order of frequency femoral and umbilical hernia. Inguinal hernia is, according to Wernher, about seven times as common as femoral hernia and about twenty-six times as common as umbilical hernia. Against 37,873 inguinal herniæ Wernher counted 5,341 femoral and 1,428 umbilical herniæ. Several herniæ sometimes occur in one person. P. Berger found among 10,000 cases of hernia 111 men and 70 women with coexisting inguinal and femoral herniæ upon opposite sides of the body, and 225 men and 15 women with these herniæ upon the same side. We have to do in such cases with unusual weakness of the whole inguino-crural region, and usually with weak, thin, sickly persons.

§ 182. **Symptomatology, Clinical Course, and Pathological Changes.**—The symptoms of hernia vary according to its location, character, and size. We distinguish first of all those that are capable of reduction and those incapable of reduction.

I. Reducible Herniæ.—The chief objective symptom of a reducible hernia consists in the presence of a tumour, especially when the patient stands or walks, and upon an increase in the intra-abdominal pressure—e. g., in coughing. A hernia that contains intestine is softer and more elastic than one containing omentum. A reducible hernia can be easily pushed back into the peritoneal cavity when the patient is lying down, and if then the tip of the finger follows the hernial contents as they slip back into the peritoneal cavity one distinctly feels the ring, especially in inguinal and umbilical herniæ, through which, in case it is large enough, the finger can pass into the peritoneal cavity. The percussion note over the tumour is tympanitic if it contains intestine; otherwise it is dull or flat.

The subjective disturbances are also very variable. At all events, the existence of a hernia restricts in different ways the patient's ability

to work. Patients complain particularly, according to the size of the hernia, of digestive disturbances, of constipation resulting from the impeded passage of fæces through the coils of intestine that lie in the hernia, of a feeling of tension, and of colicky pains in consequence of traction on the mesentery, the omentum, and the intestine that lie in the sac. These disturbances are most likely to occur after eating indigestible food. The lifting of heavy loads and long-continued walking are to a greater or less degree impossible. The chief danger is, however, that a hernia which is not completely held back by a truss may become irreducible, and that strangulation may occur, with gangrene and perforation of the intestine, followed by general peritonitis. An old surgeon once said that every person with a hernia wears his death robe. It is not so bad as that, but at all events the general health and the full capacity for labour of a ruptured person are impaired, particularly in case of an irreducible hernia.

In rare cases, rupture of all the hernial coverings occurs from injuries, from lifting heavy loads, or spontaneously, also, as the result of inflammatory processes, so that the fluid in the sac escapes, or even the hernial contents (intestine, omentum, etc.) prolapse.

Inflammation of a hernia takes place mainly as the result of mechanical injuries, and, above all, in connection with its strangulation (see below). As a result of inflammation, aside from that due to strangulation, there occur thickening of the sac, adhesions of the sac with its contents, particularly with the omentum, and less often with the movable intestine or adhesions of the contents with one another, thickening of the omentum, etc. A spontaneous cure may result from the adhesion of an empty hernial sac at its orifice. Closure of the orifice of the sac is occasionally observed also in omental herniæ. In consequence of these adhesions between the hernial contents and the sac, or of the contents with another, and in consequence also of contraction and thickening of the omentum, a hernia may easily become irreducible—that is, the hernia can no longer, as before, be pushed back into the peritoneal cavity.

As regards other inflammations of a hernia, it should be noted that acute phlegmonous processes, aside from those attending strangulation, occasionally develop, especially after wounds of the hernia. An acute phlegmon sometimes attacks old herniæ containing adherent omentum, resulting in abscess formation in the hernial sac. A short time ago I operated upon a sloughing abscess in an old omental hernia with adhesions. The patient was a woman seventy years of age. The hernia was completely shut off from the peritoneal cavity at the neck of the sac by adhesions, the strangulated part of the omentum had become

gangrenous, and the whole sac was filled with foul pus. The patient recovered. We shall have more to say later of inflammation of herniæ in consequence of strangulation.

A hernia is sometimes complicated by other diseases—e. g., with tuberculosis or carcinoma. Tuberculosis is very rare. It affects either the hernial sac or the hernial contents, or both together. The tuberculosis is only, in exceptional cases, primary in the hernia (Lejars, Jonnesco). It is, as a rule, one of the manifestations of a general tubercular peritonitis. P. Bruns and Haegler have collected in all seventeen cases from literature. A hernia may become irreducible in consequence of tuberculosis and carcinoma (see below). Echinococcus of the sac has been observed by Hunter and Berger.

II. Irreducible Hernia.—The causes, already mentioned in part, which render a hernia irreducible are the following :

1. Adhesion of the hernial contents with the sac, sometimes also of the contents with one another. The adhesion of the hernial contents with the sac occurs especially in those herniæ which are not held back by a truss, particularly in omental herniæ. Inflammatory processes usually of a chronic character lead to such adhesions.

2. Thickening and contraction of the omentum lying in the hernial sac.

3. Slight mobility in herniæ of the cæcum and the sigmoid flexure, when the mesentery with its point of insertion has descended into the hernial sac.

4. Diminution in the size of the abdominal cavity attending the long continuance of a very large hernia. In such cases reduction of a portion of the intestine is usually possible, and after a time, when the peritoneal cavity has gradually resumed its normal size, complete reduction is often possible.

5. It often occurs, in case of a large ring, that the intestine or a portion of the omentum, particularly the former, constantly comes down alongside the truss after reduction.

6. A hernia may be apparently irreducible when an empty sac is closed at its orifice by adhesions and filled with serum.

7. The most important cause of irreducibility of a hernia is strangulation, and we must occupy ourselves with this somewhat more in detail.

§ 183. **Strangulated Hernia.**—Various theories have been advanced as to the cause of strangulation or incarceration of a hernia.

According to Scarpa and Chassaignac, the chief cause of strangulation is a flexion of the intestine at the orifice of the sac, this occurring sometimes in the efferent and sometimes in the afferent portion. The flexion of the effer-

ent portion is the most important. This theory has recently been put upon a foundation of physical laws, particularly by W. Busch. The flexion occurs, according to this author, in consequence of the action of hydrostatic pressure. If fluid or air enters a curved tube ab (Fig. 477, A), or an intestinal loop in a hernia, with a definite force k , it exerts upon the walls of the intestine on the concave and convex side a definite pressure, kc and kd . In such a curved tube or intestinal loop the pressure of the contents upon the outer (convex) wall (d) is always greater than upon the inner concave wall (c). Hence an effort is made to straighten the bent tube or the intestinal loop. If the pressure k in the intestinal loop

reaches a certain height in consequence of increase in the contents (Fig. 477, B), the pressure kd exerted upon the outer wall seeks to straighten the loop in the direction of the arrows. The efferent portion will therefore be drawn down as far as the mesentery permits, but finally it becomes bent at the orifice of

the hernial sac. The afferent portion b of the intestinal loop remains open so long as the pressure in the part of the intestine located above the orifice is greater than that in the loop ab . If this relation is reversed, if the pressure in the intestinal loop becomes greater than that in the part of the intestine immediately above the orifice, the afferent portion b also becomes flexed.

The valve theory of Roser is very plausible. When an intestinal loop lying in a hernial sac is filled to the maximum, a sort of valve is formed at the orifice of the sac, inasmuch as the walls of the intestine are brought together in such a way that when pressure is exerted upon the loop the contents can escape neither from the efferent nor the afferent end of the intestine. This valve theory of Roser can easily be understood by an experiment. If one passes an intestinal loop through a ring of the size of the finger—the orifice of the hernial sac, as it were—and fills it tensely by the injection of water, not a single drop will be discharged by pressure upon the loop. By opening the loop from below or letting it freeze, it is seen that a valvelike occlusion of the lumen of the intestine has taken place at the orifice of the sac, because the folds of mucous membrane, or, more accurately, the two walls of the intestine, are laid one upon another like a valve. Bidder, who in the main adopts Roser's valve theory, emphasizes the opinion that particularly the longitudinal folds of the intestine play a part in this valvelike occlusion.

Kocher's theory is similar, to be sure, to that of Roser, but still differs from it somewhat. This theory is based upon the fact that the intestine when filled to the maximum is stretched, the mucous membrane is drawn down into the hernial ring in the form of folds, and in this way the intestine is closed tight at the ring. Through the stretching of the mucous membrane there is formed at the point of constriction—that is, at the hernial ring—a sort of

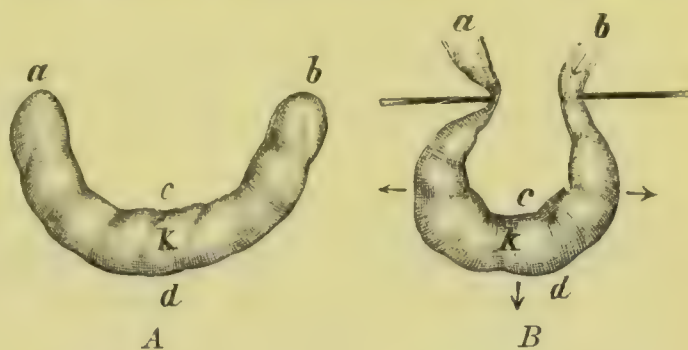


FIG. 477.—Busch's theory of strangulation.

wedge, *a* (Fig. 478, 1). If, upon the further action of the hydrostatic pressure, this wedge *a* is forced down to a point below the ring or below the point of constriction in the experiment, the intestinal contents flow through (Fig. 478, 2). If now the hydrostatic pressure increases *above* the point of constriction, the mucous membrane is drawn up out of the ring, the wedge is flattened, and the intestine is closed by the fold of mucous membrane (Fig. 478, 3).

Finally, Lossen's theory should be mentioned. The credit belongs to Lossen of having again revived the question as to the cause of strangu-

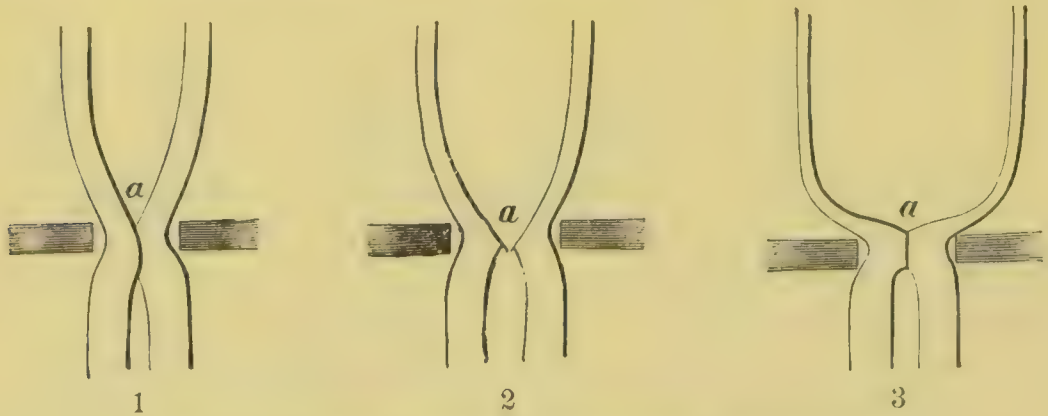


FIG. 478.—Kocher's theory of strangulation (diagrammatic).

lation by recent ingenious experiments. He came to the conclusion, as the result of his experiments, that the efferent portion of the intestine *a* (Fig. 479) is so compressed in the hernial ring by the tensely filled afferent portion *z* that the former is completely closed. Lossen's explanation then met with animated contradiction, particularly from W. Busch and Roser, and, as a matter of fact, the condition described by Lossen seems scarcely at all, or at all events very seldom, to occur in man; at least it has not yet been found in performing herniotomy.

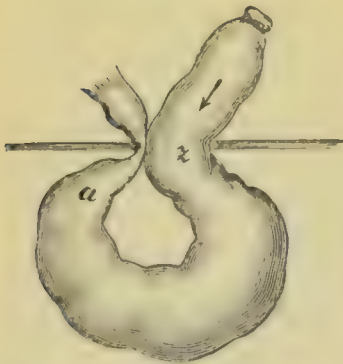


FIG. 479.—Lossen's theory of strangulation.

Of the theories that have been mentioned, that of Scarpa and W. Busch has the best foundation on physical laws, and the valve formation claimed by Roser and Kocher's related theory of the stretching of the mucous membrane have also been shown to be actual causes of strangulation. The condition described by Lossen probably occurs least often.

All these theories are confined to the explanation of strangulation when the intestine is tensely filled or inflated; but frequently one finds the strangulated intestine comparatively empty. In such cases the small size of the ring probably plays an important part—i. e., in consequence, for example, of increased abdominal pressure, a loop of intestine has suddenly passed through a very narrow orifice, and the constricting ring is too small to allow even the empty loop to pass back. The hernial sac in such cases was either empty before or it contained omentum. The intestinal contents play no part in this form of strangulation.

Volvulus or intussusception of the intestine in a very large hernia, and constriction by fibrous bands in the hernial sac, may cause strangulation of an intestinal loop in much the same way as in the abdominal cavity (see § 168, page 111). In all these cases the contents of the intestine are only of secondary importance in the causation of its occlusion.

We come, then, to the conclusion that the occurrence of strangulation of a hernia is conditioned upon various causes, and that, ætiologically, three main kinds of strangulation are probably to be distinguished: First, strangulation from maximum distention of an intestinal loop with faecal contents (also called faecal strangulation), for which we have given the above attempts at explanation by Scarpa, W. Busch, Roser, Kocher, and Lossen; second, strangulation of the empty intestine, due to a very small ring; third, strangulation of the intestine from volvulus, intussusception, fibrous bands, etc.

Symptoms of Strangulated Hernia.—The first symptom of a strangulated hernia consists in the fact that a hernia hitherto reducible can not be pushed back into the peritoneal cavity. The hernia feels harder and becomes more and more tender. The greater resistance and the tenderness on pressure are conditioned in part upon the distention of the strangulated loop of intestine and in part upon the acute inflammation. The serous transudation within the sac from the blood-vessels of the intestine, in consequence of the venous engorgement, should likewise be considered, as it is due to this in part that a strangulated hernia feels more tense. Micro-organisms are often present in the serous fluid within the hernial sac very soon after strangulation has begun, and before any serious organic changes have taken place in the wall of the intestine. They come from the interior of the bowel, and pass through its wall. They include staphylococci, streptococci, diplococci, and the *bacillus coli communis*. Out of fifty-two cases, they were present in fifteen (Tietze). Their presence is hence not constant, and they may be absent even in a gangrenous hernia. The fluid in the sac has a destructive action upon certain forms of bacteria.

The amount and character of the fluid bear a certain relation to the degree and duration of the strangulation. The more fluid there is, the more complete and the longer the duration of the strangulation. If the fluid is distinctly bloody and mixed with flakes of fibrin, even though small in amount, it usually indicates serious changes in the bowel. The inflammation of the strangulated hernia increases usually to such an extent that there is reddening and swelling of the overlying skin. In even the worst degrees of strangulation, however, with anæmia of the loop of intestine, the swelling and inflammatory infiltration may be absent and the hernial tumor remain soft. One should not be deceived by such a local condition of a strangulated hernia.

In the further course of a strangulated hernia the symptoms of intestinal obstruction, as described in § 168, page 116 ff., become more and more prominent, especially constipation, vomiting going on to faecal vomiting, and symptoms of collapse. The symptoms of obstruction often appear very early and increase rapidly. The intestine is correspondingly distended above the constriction, in consequence of the impeded passage of the faeces and the intestinal gases, and the abdomen is therefore enlarged. The symptoms of complete occlusion of the intestine may be absent in case of a so-called partial enterocele (Littre's hernia), in which only a portion of the intestinal wall is strangulated (Fig. 480).

If the strangulated loop of intestine is not liberated with sufficient promptness, gangrene follows with perforation of the bowel, sloughing



FIG. 480.—Littre's hernia (diagrammatic).

of the entire hernia, and general septic peritonitis. The gangrene of the intestine is either a localized process at the constricting ring, due to circulatory disturbances, or a gangrene of the whole loop of intestine caused by anæmia from immediate cutting off of its blood supply, or by thrombi in the arteries and veins.

The mucous membrane of the intestine may be extensively necrosed, and yet the bowel show no appreciable changes externally. At the beginning of the strangulation the portion of the intestine involved is hyperæmic, dark red, then reddish brown, dark blue, and when the gangrene is pronounced, perfectly black. One usually observes, in case of gangrene and perforation of the intestine, inflammatory reddening of the cutaneous coverings and emphysematous crackling deeper down. After the sloughing abscess ruptures, an abnormal anus is formed, if death from peritonitis and sepsis does not first ensue. Gangrene of the intestine is sometimes present twenty-four hours after strangulation has begun. In other cases it does not take place for several days. The smaller the ring and the more the intestine is filled—in a word, the more pronounced the causes which we have emphasized above in connection with the etiology of strangulation—the more speedily does gangrene make its appearance.

There are usually marked circulatory disturbances in the entire intestinal tract, caused by the obstruction to the portal circulation and reflex diminution in the strength of the contractions of the heart. This explains the hæmorrhages from the stomach and intestine from vomiting, and the thrombosis of the mesenteric vessels and of the branches of the portal vein in the liver.

The commencement of peritonitis is indicated by an increasing

rigidity and tenderness of the abdomen. Even without gangrene of the intestine suppurative and septic peritonitis may result in consequence of the micro-organisms which pass through the wall of the gut into the fluid within the hernial sac.

Of other disturbances of the general condition of the patient, fever should be especially mentioned. Fever, however, is not a reliable guide in determining the degree of the strangulation. The temperature is often enough normal or subnormal, and still death follows from increasing collapse. The pulse is more characteristic. It is always very rapid, and the pulse wave is low in consequence of the reflex paresis of the heart muscle arising from over-irritation of the sensory nerves of the intestine. Thus is explained why death sometimes occurs suddenly from paralysis of the heart or from collapse. The patient finally becomes very weak in consequence of the disturbed nutrition and the diminished action of the heart. The inflammation of the lungs that sometimes occurs in connection with a strangulated hernia is, according to Gussenbauer, of embolic origin, conditioned upon infected thrombi transported from the strangulated portion of the intestine and mesentery. The correctness of this assumption of Gussenbauer was experimentally demonstrated by Pietrzikowski, and anatomically and bacteriologically verified by F. Fischer and E. Levy. Some have erroneously regarded the consolidation in the lungs as merely aspiration pneumonia. In strangulation of omentum there is increasing pain in the region of the hernia as well as obstruction to the passage of faeces and vomiting. Similar symptoms of peritoneal irritation are seen also in connection with the strangulation of other abdominal organs—e. g., the ovary. The incarceration of omentum leads less often to gangrene, but usually to an adhesive inflammation by which the hernia becomes permanently irreducible.

The prognosis of strangulated hernia containing intestine is unfavourable unless the strangulation is overcome with sufficient promptness. Death may ensue either from collapse, from reflex paralysis of the heart, in consequence of the over-irritation of the nerves of the intestine, from ptomaine poisoning, with rapid loss of strength, and, above all, from gangrene and perforation of the intestine with septic peritonitis. The latter is conditioned either upon sloughing of the hernial sac in consequence of gangrene of the intestine or upon septic infiltration of the wall of the intestine, resulting from the decomposition of the intestinal contents above the constriction. A spontaneous cure sometimes occurs from self-reduction of the hernia, or from the formation of a faecal fistula after perforation of the intestine. If reduction of the hernia is promptly accomplished by taxis or by an operation, the prognosis is favourable, the more so if the operation is performed aseptically. According to Schede, the mortality attending strangulated hernia averages twenty-four per cent. Even after the strangulation has been overcome its

symptoms may sometimes continue, especially vomiting, in consequence of paralysis of the splanchnic nerve and the paralysis of the intestine conditioned thereupon (Trier).

The prognosis of irreducible hernia is in general unfavourable, in view of the fact that strangulation may occur at any time.

The diagnosis of a strangulated hernia is clear from the above-described characteristic symptoms, especially from the fact that the hernia is irreducible, and its local condition in other respects. In strangulation of intestine the obstruction to the passage of faeces becomes especially prominent (constipation, faecal vomiting, tympanites of the intestinal coils above the constriction, etc.), also the symptoms of acute peritonitis, the above-described general condition, etc.

The reader is referred for the diagnosis of irreducible hernia to the description of the different forms of hernia.

§ 184. **General Treatment of Hernia.**—We shall take up first the treatment of completely reducible herniæ.

Every reducible hernia should be held back by a proper truss applied after reduction has been fully accomplished, and with the patient lying down. It is possible that in this way, especially among children and young persons, an adhesion of the orifice of the hernial sac, and so a permanent cure, may finally occur. Such a cure is but rarely observed among adults, occurring most frequently when the ring is small. A truss should also be worn, as a matter of precaution, in cases where there is as yet no hernia proper, but there is a tendency in that direction from relaxation of the abdominal wall—e. g., in the region of the inguinal and femoral canals. The surest method of curing a reducible hernia is by a radical operation, and in rare cases also by the injection of tincture of iodine, a strong solution of salt, alcohol (absolute alcohol and sterilized water in the proportion of two to one or in equal parts, one or two injections with a hypodermic syringe once a week near the external ring; see also page 201). The operative treatment of a reducible hernia (see page 196) is indicated in all those cases in which a hernia can not be held back by a truss. The operation is also indicated in irreducible and strangulated herniæ.

The form of truss varies according to the location of the hernia, or, in other words, the anatomical character of the hernial ring. In taking up the separate forms of hernia we shall consider the various suitable trusses more in detail. Only the following brief statement need be made here:

Trusses should never be made from a general model, but should be adapted to each individual case. The hernial ring in question should be so closed by the truss that the hernia is securely and completely held back. Trusses usually produce their effect by the elastic pressure of a pad, which is ordinarily convex and which is attached to the end of a cushioned steel spring. The pad may also be in the middle of the truss, as, for example, in the case of an umbilical hernia. The usual fastening of the pad at the end of the spring is

sometimes immovable and sometimes freely movable or capable of adjustment in a definite way. The pad is differently made, according to the location of the hernia. For small irreducible herniæ hollow pads are occasionally used. The elastic power of the spring is sometimes greater and sometimes less, to correspond with the greater or less pressure of the intestines. Soft, elastic, well-cushioned pads are preferable to hard ones made of wood, India rubber, bone, etc. Pads filled with air or glycerin are very agreeable but not durable. It is of special importance that the pads be large enough, and that they project on all sides beyond the hernial opening. Too small pads, which merely lie in the hernial ring, have an injurious effect, because they tend to enlarge the ring. V. Fischer has recently recommended trusses which have a steel spring, which is capable of regulation, screwed to the front side of the pad, by which the direction and the intensity of the pressure of the pad can be changed as necessity requires. The patient should be thoroughly instructed by his physician in the use of the truss, and his attention should be called to the dangers of a possible strangulation of the hernia in case the truss does not fit well or if no truss is worn. The application of a truss by a truss-maker alone is not advisable. The supervision of a physician is absolutely necessary.

The truss should be applied while the patient is in a horizontal position, after complete reduction of the hernia. It should also be removed while the patient is lying. It need not be worn at night, as a rule; but if the patient has a cough or the hernia is very large, it should be worn day and night. A truss should only be designated as suitable when it holds the hernia back completely and painlessly in spite of the most severe abdominal pressure and the most varied movements of the body. If the intestine or omentum comes down alongside the truss, or the latter becomes displaced, it is unsuitable for use. One should always advise the patient to buy two trusses, in order that he may have another in reserve in case one becomes defective.

§ 185. **Treatment of Strangulated Hernia.**—The reduction of a strangulated hernia can be accomplished either in a bloodless way, by so-called taxis, or by an operation (herniotomy). A strangulated hernia may only be replaced by taxis when one is sure that the intestine has suffered no serious disturbances of nutrition. If it has thus suffered, it should be exposed by an operation and treated according to the condition of things that is found (see Herniotomy). In all doubtful cases one should resort to the knife, and only make use of taxis when the strangulation has existed a very short time and no threatening symptoms of a local or general nature have appeared. A definite time up to which taxis may be resorted to can not be stated. The more severe the strangulation of the intestine, the sooner do disturbances in the nutrition of the latter appear. Small, tightly strangulated herniæ are no longer suited for treatment by taxis after a few hours, while in very large strangulated herniæ the intestine is often in thoroughly good condition after several days, so that reduction by taxis is permissible. One should always remember that herniotomy, performed under antiseptic precau-

tions, is an operation unattended by danger, and that we can thus inform ourselves in the best and surest way as to the condition of the strangulated bowel.

Taxis varies somewhat in the different forms of hernia, but the following rules for it may be given as generally applicable: It is first tried without an anæsthetic, the patient being in the horizontal position. If it is unsuccessful, the patient is put under an anæsthetic, for the further reason that, if taxis fails, herniotomy can be performed at once. Whenever taxis is performed, one should give the patient such a position as to relax as far as possible the abdominal wall or the hernial ring—that is, elevate the pelvis and flex the hips and knees. Extension of the lower extremities is serviceable only in ischiatic hernia and flexion, and abduction of the same only in obturator hernia. One should begin reduction, especially in large herniæ, by pushing back the parts of the intestine that lie nearest the ring. For this purpose the base of the hernia is grasped with the fingers and the attempt made by drawing upon it as well as by pushing the hernia this way and that, to loosen, as it were, the ring. Pressure is then made on all sides with the fingers of both hands upon the base of the hernia, in order to push back the contents of the incarcerated intestinal loop through the hernial ring. In large herniæ one advances in this way from the base to the periphery—that is, in inguinal hernia from above downward. In making these manipulations care must be taken that the intestine, when pressed from one side, can not slip away to the other side, and the best way is, therefore, to grasp or compress the base of the hernia on all sides by using the fingers of both hands. If the intestinal gases pass back from the hernia into the peritoneal cavity with a gurgling sound, and if the hernia becomes smaller, taxis is usually successful.

Aside from compression, reduction may also be accomplished by traction—i. e., stroking the abdominal wall from the neck of the sac upward with the two flat hands—e. g., in cases of inguinal hernia, less often in treating femoral hernia. Elevation of the pelvis and the genu-pectoral posture recommended by Nicolaus, or the Sims lateral position, have a similar effect, inasmuch as the intestinal loops by their weight exert traction upon the strangulated intestine, and draw it back into the peritoneal cavity. The surest indication that taxis has been fully successful is the disappearance of the hernial tumour, so that one can insert the tip of the finger into the internal ring. The patient feels relieved at once, and the symptoms of strangulation cease.

Various means of aiding taxis have been recommended. The chief of these, as already mentioned, is anæsthesia. Warm baths, the use of an ice bag, and the local action of ether spray are also very serviceable. Finkelstein

recommends pouring ether every fifteen minutes upon the hernial tumour and the vicinity of the ring. The skin of the penis, the scrotum, and the labia should be smeared with oil beforehand. Gussenbauer successfully applied this ether treatment, combined with elevation of the pelvis and the use of the ice bag, in the treatment of sixteen strangulated inguinal herniæ, three femoral herniæ, and one para-umbilical hernia. The hernia was reduced in from one to six hours. Wherry recommends having the patient cough while taxis is being used, which causes alternating contraction and relaxation of the ring. Hagen speaks highly of the action of belladonna and atropin, which cause a contraction of the vessels of the mesentery and stronger peristalsis. The application is made in the form of an ointment in the region of the hernial tumour, or, better, as a hypodermic injection in the direction of the neck of the sac and the ring.

Attempts at taxis are cautiously made at first in all cases. Other methods of reduction are antiquated and are to be rejected as injurious, inasmuch as they unnecessarily protract the duration of the strangulation. Such are the injection of morphine near the neck of the sac (Ravoth), strong enemata calculated to excite peristalsis—e. g., infusion of tobacco, electricity, relaxation of the strangulated loop of intestine by puncture and aspiration with very small hollow needles, etc. Modern surgery no longer employs any of these doubtful aids of taxis. If taxis is not successful when tried under an anæsthetic in the above-described simple manner, we proceed at once to the performance of herniotomy, expose the strangulated intestine, and, if it is in a suitable condition, reduce it after enlargement of the ring with the knife.

Improperly performed taxis may be followed by various unfortunate occurrences. Taxis is sometimes apparently successful—that is, the hernia has been returned into the peritoneal cavity, but the symptoms of strangulation still continue. This apparent reduction of a strangulated hernia is conditioned usually upon the fact that the hernia—that is, the hernial contents and the sac—is reduced as a whole and lies within the peritoneal cavity or in a properitoneal pouch between the abdominal wall and the detached peritonæum (Fig. 481).

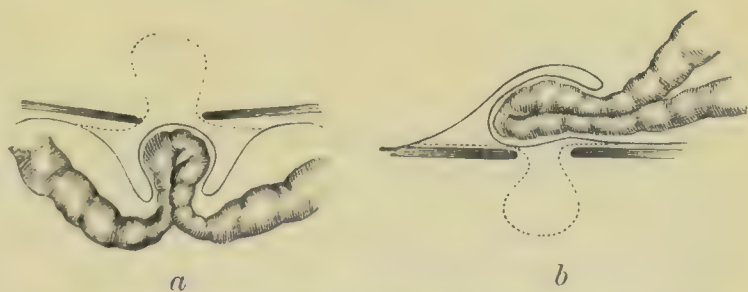


FIG. 481.—Reduction *en masse* of a strangulated hernia (diagrammatic).

By rough, violent taxis the constricting neck of the hernial sac may be completely torn away from the body of the sac as well as from the parietal peritonæum, and thus be reduced at the same time (Streubel). The reduction *en masse* is sometimes not complete, and the hernia still lies partly in the hernial ring and can be felt there. In the latter case the deception is not so

pronounced as when the sac and its contents are replaced completely inside the peritoneal cavity.

The symptoms of strangulation may also continue in case of a hernia strangulated by volvulus or intussusception, if the latter still exist after the hernia has been reduced.

In cases of apparent reduction—that is, when the pain and the symptoms of strangulation continue after the hernia has been reduced—the abdominal cavity should be opened at the proper place and the cause of the strangulation determined and overcome.

Of other unfortunate occurrences attending taxis, there should be mentioned, finally, the reduction of a loop of intestine that is already gangrenous, or rupture of the strangulated intestine and the hernial sac in consequence of the use of too much force in performing taxis. Death from septic peritonitis is as good as certain in both cases. One should, however, in case this happens, still make an effort to save the patient by laparotomy, resection of the intestine, and enterorrhaphy (see pages 121–125; also Peritonitis, § 158, page 37; and Laparotomy, § 159, page 45).

Herniotomy is to be performed as soon as possible in case taxis is unsuccessful, or may no longer be undertaken on account of too long continuance of the strangulation. The operation is performed under a strict observance of antiseptic precautions, and consists of the following acts: 1. Dividing the layers of tissue down to the hernial sac. 2. Opening the sac. 3. Enlarging the constricting ring with the knife. 4. Returning the hernial contents into the peritoneal cavity after the intestine has been examined in its entire extent to determine whether or not it is still in a suitable condition for reduction.

Before the introduction of antiseptic methods surgeons were afraid of opening the peritoneal cavity, and herniotomy was therefore performed without opening the sac—that is, the sac was exposed, the hernial ring enlarged, and the intestine returned without being examined. This extraperitoneal herniotomy has been abandoned in modern surgery. We always open the sac so as to be able by inspection of the strangulated intestine to determine whether it already shows serious disturbances of nutrition, whether gangrene is threatened, etc.

We shall describe the special technique of herniotomy more fully in treating of the different forms of hernia. We therefore confine ourselves here to a few general remarks.

After careful disinfection of the field of operation, the overlying skin is raised in the form of a fold and divided to the proper extent over the longest diameter of the hernial tumour. The upper end of the incision lies somewhat above the neck of the sac. The separate

coverings are then divided down to the sac, each being lifted by two pairs of mouse-toothed forceps. The recognition of the hernial sac is not always easy. It is often recognised by the fluid contents which glimmer through and by the pedicle which extends into the hernial ring. The hernial ring is the best landmark in determining the sac. The surest evidence that the sac has been opened is afforded by the fact that one can push the tip of the finger under or into the constricting ring. The hernial sac is sometimes absent—e. g., in herniæ of the cæcum.

The sac is opened by lifting up a fold with mouse-toothed forceps and carefully cutting into this with a knife held flat or turned obliquely upward. The fluid within the sac then escapes, and the small opening is enlarged with a blunt-pointed bistoury or the fingers. The sac is then divided with scissors as far as the ring upon the left forefinger, which is introduced.

The constricting ring is now divided with Cooper's herniotomy knife (Fig. 482) or a blunt-pointed bistoury, the contents of the hernia being protected by the dorsal surface of the left forefinger. The bistoury is laid flat upon the palmar surface of the left forefinger and carried through the hernial ring, whereupon the edge of the knife is directed toward the constriction and the latter is divided. Instead of dividing the ring as just described, it is an excellent plan, especially where gangrene of the gut is suspected, to divide the constricting ring or the entire inguinal canal from above or from within the peritoneal cavity. After the constriction has been overcome the intestine is drawn out and examined to a point above the strangulation. If in doubtful cases common salt is now placed upon the intestine above the point of constriction, and it is seen that the peristaltic movements caused thereby spread over the strangulated part of the gut, the intestine in question possesses sufficient vitality and may be returned. Strangulated intestine is hyperæmic and dark red. A black or blackish-brown colour is a sure sign of gangrene, and such an intestine must never be replaced. If the intestine is in a proper condition to return, it is carefully disinfected with 1-to-1,000 bichloride, whereby an assistant should close the orifice of the sac with the finger, in order that the bichloride may not flow into the peritoneal cavity. In performing reduction the portion of the bowel that lies nearest the orifice of the hernial sac is replaced first.

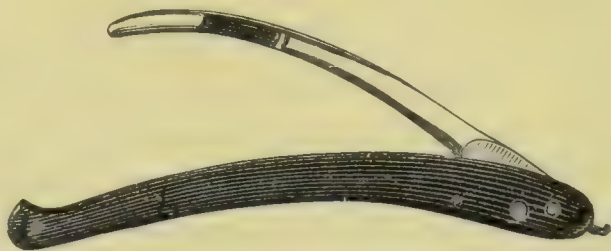


FIG. 482.—Cooper's herniotomy knife.

After reduction of the entire contents of the hernia, one satisfies himself that everything is right by pushing the finger through the ring into the peritoneal cavity.

In suitable cases a so-called radical operation may now follow. For a more detailed description of the radical operations for hernia the reader is referred to § 186, pp. 195–201. There follow, finally, disinfection, drainage, and suture of the external wound, and the application of an antiseptic protective dressing.

A black loop of intestine which arouses suspicion of gangrene must not be returned into the peritoneal cavity. In such a case, after the hernial ring has been enlarged, the intestine is fixed in the wound or to the abdominal wall by means of a loop of silk passed through the mesentery, or by means of a few stitches through the serous coat of the intestine; the latter is carefully enveloped in sterilized gauze and further developments are awaited. The loop of thread must be so applied as not to constrict the bowel. If the intestine is restored to life, it often retracts spontaneously after the removal of the loop of silk or the stitches, or it is carefully disinfected and replaced. If gangrene ensues, the intestine is either resected immediately, or, better, an artificial anus first made within the sac (see page 127). In cases in which there is doubt whether the strangulated gut will become gangrenous or not, and hence the same can not be replaced, Helferich recommended lateral anastomosis between the afferent and efferent portions of the intestine about a hand's breadth above and below the point of strangulation. If the bowel resumes its vitality, the adhesions about the hernial ring are freed and the intestine thoroughly disinfected and returned into the peritoneal cavity. If gangrene results, the intestine is resected and the two ends closed by Lembert sutures. If gangrene is found at the outset, the necrotic portion is resected as far as possible from the line of demarcation, the ends sutured together, and the intestine returned into the peritoneal cavity, or an artificial anus may be formed. In case the latter procedure is decided upon, the involved intestinal loop is attached to the edges of the skin on all sides by Lembert sutures, the intestine is opened, and the gangrenous portion removed. If a whole loop of intestine is gangrenous, or if the entire cross-section of the gut necrotic, both ends should be sutured to the edges of skin and the gangrenous part excised transversely. The escape of fæces may be facilitated by the introduction of an India-rubber tube into the proximal end of the intestine. The artificial anus is subsequently closed by destroying the spur or by detaching the gut, resecting it, and performing circular enterorrhaphy (see page 123). In case the intestine within the sac has already perfo-

rated and a faecal abscess developed, the latter should be freely opened, and here also the intestine sutured to the edges of the skin. The above-described formation of an artificial anus was at one time preferred to primary resection of the bowel, because the results of the latter operation were unfavourable on account of the inflamed condition of the intestine and its tendency to progressive gangrene. Of late, however, better results have led to the readoption of primary resection in preference to the formation of an artificial anus. It is particularly important that the intestine should be resected at a considerable distance from the gangrenous area, and that the operation should be performed quickly and skilfully.

Laceration or rupture of the intestine in continuity—e. g., from violent taxis or from traumatism—is treated, generally speaking, according to the same rules that we have just described for threatened or already existing gangrene from strangulation.

In rare cases strangulation of a loop of intestine which has been relieved by herniotomy may be followed by cicatricial stenosis of the bowel, either in the form of an external groove in the peritoneal coat due to cicatricial contraction after the healing of gangrenous areas in the constricted part of the intestine, or in the form of a long, annular stricture due to destruction of the mucous membrane.

Various anomalies of the hernial sac are of importance in connection with herniotomy, and every surgeon should be familiar with them. Two or more sacs sometimes exist which lie above or beside one another, and which communicate one with another or present separate serous cysts.

Diverticula—that is, pouchlike protrusions of the hernial sac—are found, especially in inguinal and femoral herniæ, on the body of the sac, as well as at its neck, and several such diverticula sometimes exist. The diverticula are in open communication with the sac, and either contain omentum or intestine, or a serous fluid only.

There are sometimes two hernial sacs entirely separated from one another and lying beside each other. They are either both filled with abdominal viscera, or the latter are found only in one of them, while the other is empty or has only fluid contents. The two sacs are usually adherent to one another, and they either lie side by side, or one lies in front of the other. They sometimes lie one above the other—when, for example, the first sac is pressed downward *in toto* by a second one. In such cases the two together have the form of an hour-glass. By further formation of hernial sacs above the first, a row of sacs may be formed (*hernie à chapelet*). The sac which first appears is sometimes not pressed downward *in toto* by a second sac, but the second is invaginated into the original partly closed sac, so that a double hernial sac may result.

§ 186. **The Radical Cure of Hernia.**—We have already briefly referred to the radical cure of hernia as the final act in operating upon stran-

gulated hernia. We shall here speak chiefly of the radical cure of non-strangulated herniæ. It is indicated especially in those cases where, in consequence of its size or for other reasons—e. g., adhesions of the hernial contents with the sac—a hernia can not be held back by a truss. If a hernia can be completely held back by a truss a radical operation should not be resorted to, especially as a permanent cure can not be guaranteed.

In dealing with a large old hernia Küster recommends that the stomach be washed out before the operation, in order to facilitate the reposition of the intestine and to avoid the danger of aspiration of stomach contents into the air passages. Küster lost one patient from this cause during the operation.

To the question whether children in their first or second year should be operated upon in case they have herniæ which can not be held back by a truss, I must give a decided affirmative answer. I have operated upon and cured a large number of herniæ in children soon after birth and later—in their first or second year—without a single death and with the best results, adopting either the method of Macewen, Bassini, or my own.

The idea of curing hernia “radically” by operation is an old one, and the radical operation was performed by travelling surgeons, especially in the middle ages, in the most unheard-of manner sometimes; in scrotal hernia, for example, by castration. The invagination of the hernial sac—e. g., in inguinal hernia—by infolding the scrotal skin into the inguinal ring by suture or by special apparatus (invaginators), after Gerdy, Wutzer, Rothmund, and others, has been wholly abandoned. The closure of the hernial ring and the neck of the sac by suture, which was first practised by the American Dowell and the Englishman John Wood in the second half of our century, is more rational. New methods have been devised of late by Steele, Nussbaum, O. Risel, Annandale, Schede, Czerny, Barker, Macewen, Wölfler, Bassini, Kocher, Küster, the author, and others, of which I consider those of Macewen, Bassini, Barker, and Kocher the best.

The Different Operations for the Radical Cure of Hernia.--We shall first mention suture of the neck of the sac and the hernial ring, as well as simple ligation of the neck with removal of the sac that has been freed on all sides. Silk should always be used as suture material, as catgut is not sufficiently durable and can not be sterilized as completely. After the sac has been opened, its neck and then the ring are closed by a continuous suture with silk, and the sac is finally removed below the suture. Any portions of omentum that may be adherent to the sac are removed, and the stump of the omentum, which is tied off in sections, can be pushed back as a plug into the hernial ring. The separation of large adherent sacs is difficult, and one must

here be on his guard, in dealing with inguinal herniæ, against injury of the spermatic cord and the testicle. In such cases of inguinal hernia, Czerny recommends suturing the neck of the sac from the inside. After the hernial sac has been divided and the hernial contents have been returned into the peritoneal cavity, the edges of the neck of the sac are held apart by means of artery clamps, so that one can properly see into it. A continuous suture with silk is then applied to its serous surface from within. The sac, which has been drawn outward with clamps, is then let loose, and the neck of the sac retracts as far as the internal inguinal ring. After continuous suture of the hernial ring and disinfection and drainage of the sac, which is not removed, the external wound is sutured. In cases where it was impossible to isolate the sac the testicle has also been removed.

Simple ligation of the neck of the sac is another method. After reduction of the hernial contents the sac, which has previously been opened and freed



FIG. 483.—Skin incision along the course of the inguinal canal in Macewen's operation.

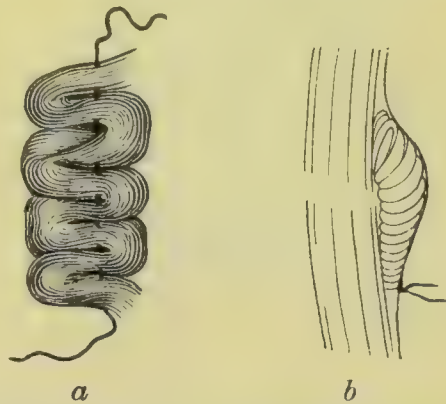


FIG. 484.—*a*, sac folded together by means of a continuous suture; *b*, the sac after being rolled up in the form of a pad and inserted between the detached peritonæum and the abdominal wall.

on all sides, is tied off with catgut, or, better, with silk, as high as possible. Ball, Stoker, and others recommend twisting the sac before tying it off. Barker ties off the sac in the usual way, and then threads each of the ends of the silk ligature into a needle, which he passes from within the internal ring through the external oblique muscle, while the stump of the sac is returned into the peritoneal cavity with the fingers of the left hand. The ends of the ligature are then tied together firmly, and the internal inguinal ring is thus closed. Among thirty-three cases thus operated upon, Barker had but two recurrences.

Macewen retains the sac and folds it together, so that it forms a pad, or invaginates it and then draws it together with a purse-string suture. This pad is pushed through the internal inguinal ring and here attached by suture, after the neck of the sac and the peritonæum have been detached with the finger, so that a space is formed between the peritonæum and the abdominal wall (Fig. 484, *b*). The edges of the inguinal canal are then sutured together over the pad (Fig. 485), and this is best done by means of Macewen's needles, pictured in Fig. 486. The external wound is sutured, except the lower angle, which remains open. The wound heals in a few days. The principle of this method, as regards the treatment of the hernial sac, may be

applied to other herniæ. Macewen does not allow his patients to get up for six weeks. The results are most excellent. Lucas-Championnière, after laying open the inguinal canal and tying off the sac, removes the sac, its neck, and the funnel-shaped protrusion of the peritoneum at the internal ring, and then inserts interrupted and mattress sutures which take in the peritoneum, which is drawn outward, the internal ring, and the remaining soft parts.

Lauenstein has recommended, as a

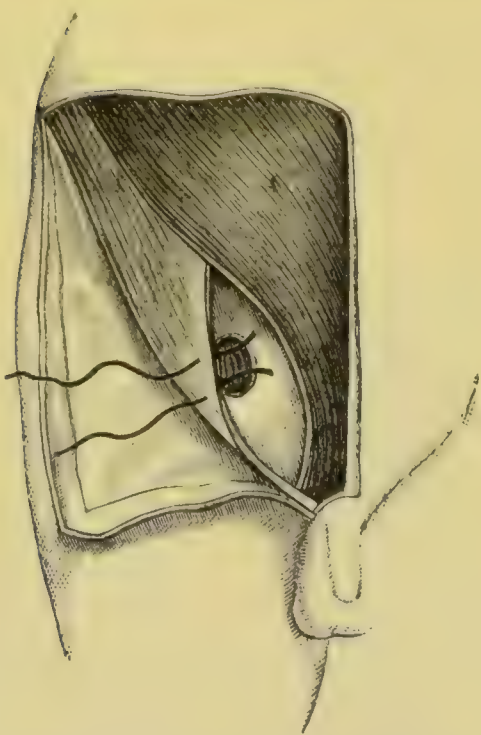


FIG. 485.—Closure of the inguinal canal over the pad by means of a mattress suture (see Fig. 484, *b*).

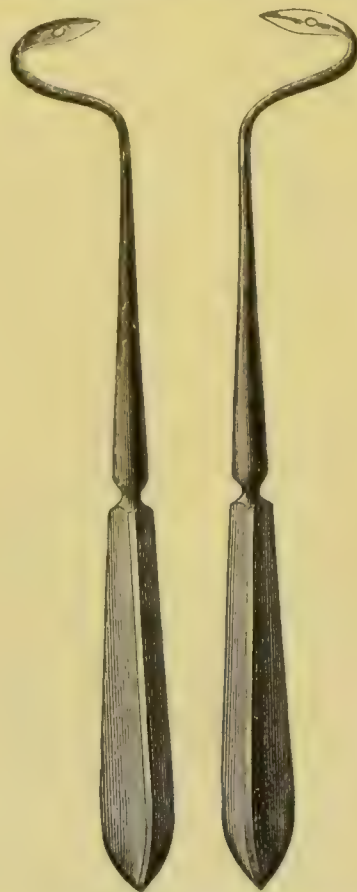


FIG. 486.—Needles for the insertion of the mattress sutures.

modification of Macewen's method for cases of congenital inguinal hernia with incomplete descent of the testicle, that the latter be returned, at the same time with the hernial sac, into the peritoneal cavity, because the detachment of the sac from the spermatic cord and the testicle is difficult in such cases.

Trendelenburg, for the sake of making the closure of the abdominal wall more secure, chiselled a pedunculated flap of periosteum and bone from the symphysis, four centimetres long, three centimetres broad, and three centimetres thick, which he inserted within the inguinal canal and sutured it to the internal inguinal ring without compressing the cord. He used the same method to advantage in femoral hernia.

Wölfler recommends the following method of radical operation for inguinal hernia, which is similar to that of Bassini (see below): 1. An incision is made over the external inguinal ring and the external oblique aponeurosis divided. 2. The hernial sac is opened without being isolated and its entire inner surface is cauterized by means of the thermo-cautery. The neck of the sac is then closed by a circular suture from the inside. 3. The internal oblique muscle is sutured to Poupart's ligament and the rectus muscle is like-

wise drawn over to Poupart's ligament, and sutured to it. The external oblique aponeurosis is finally sutured, with the exception of a small opening left for the passage of the spermatic cord.

Bassini's operation for inguinal hernia is an excellent one. He has used it in four hundred and sixty-two cases with marked success. Recurrences amount, according to Bassini and Dandelo, only to from three to ten per cent. The operation is briefly as follows: The aponeurosis of the external oblique muscle is exposed and divided from the external ring to a point beyond the internal ring, and detached above and below in the form of flaps. The cord and the sac are lifted up as a whole and isolated with the finger from their surroundings. The hernial sac is opened, its contents returned inside the abdomen, the neck of the sac is twisted and tied off, and the sac is removed beneath the ligature. The spermatic cord is lifted upon the anterior abdominal wall and a new posterior wall of the inguinal canal is formed by suturing the posterior border of Poupart's ligament to the conjoined tendon. Interrupted silk sutures are employed. The first two stitches applied close to the os pubis should also include the external border of the rectus muscle. The spermatic cord is then replaced and the aponeurosis of the external oblique muscle is sutured over it. The skin incision is closed without drainage.

Halsted's method of operation is essentially the same as that of Bassini. He places the cord between the external oblique fascia and the skin.

Postempski has so far modified Bassini's operation that, instead of restoring the posterior wall of the inguinal canal, he obliterates it and its rings and displaces the spermatic cord. There was a recurrence in only five out of sixty-two cases, and this was cured by a second operation.

Of late I have used the following simple method, which Küster and Girard also employ: 1. The sac is tied off as high up as possible. 2. The hernial ring or the hernial canal is closed by deep silk sutures (in inguinal herniæ after Bassini's method), the cord being pressed back. 3. Suture of the wound. Any large spaces are avoided by means of the sutures. In case the sac can not be isolated its neck should at least be freed and tied off.

Kocher operates as follows: A skin incision is made over the inguinal canal and prolonged upward parallel to Poupart's ligament. The soft parts at the external ring (external spermatic fascia, cremaster, and infundibuliform fascia) are then divided, the sac completely isolated with the fingers, and the left forefinger introduced into the inguinal canal. An artery clamp, or better a suitably curved forceps, is then inserted through the aponeurosis of the external oblique muscle and the underlying muscular fibres of the internal oblique and transversalis to the outside of the internal ring and carried along the left forefinger and out through the external ring. The base of the sac is then seized with the forceps and brought out through the opening in the aponeurosis (Fig. 487). The sac, having been pulled through the opening with considerable force, is then sutured to the outer surface of the external oblique fascia and cut off. The sutures, *a*, then inclose the neck of the sac and draw both it and the hole in the fascia together. The inguinal canal is narrowed by deep sutures. The cord must be constantly looked out for so as not to be wounded. This method also gives excellent results.

Bottini operates upon inguinal hernia as follows: 1. The entire inguinal canal is laid open and the sac isolated. 2. Incision and removal of the sac

after its contents have been returned into the peritoneal cavity. 3. Closure of the internal ring by means of two curved Hagedorn needles and catgut, the upper needle being also passed through the edge of the internal oblique and transversalis muscles and the aponeurosis of the external oblique, and the lower needle below and within through Poupart's ligament. 4. Suture of the remaining divided soft parts. In femoral hernia he unites in the third step the internal opening from below upward with Gimbernat's ligament.

The isolation of the sac in women with inguinal hernia is often impossible without removing at the same time the round ligament (Lucas Championnière). One should always carefully examine the tube and ovary on the

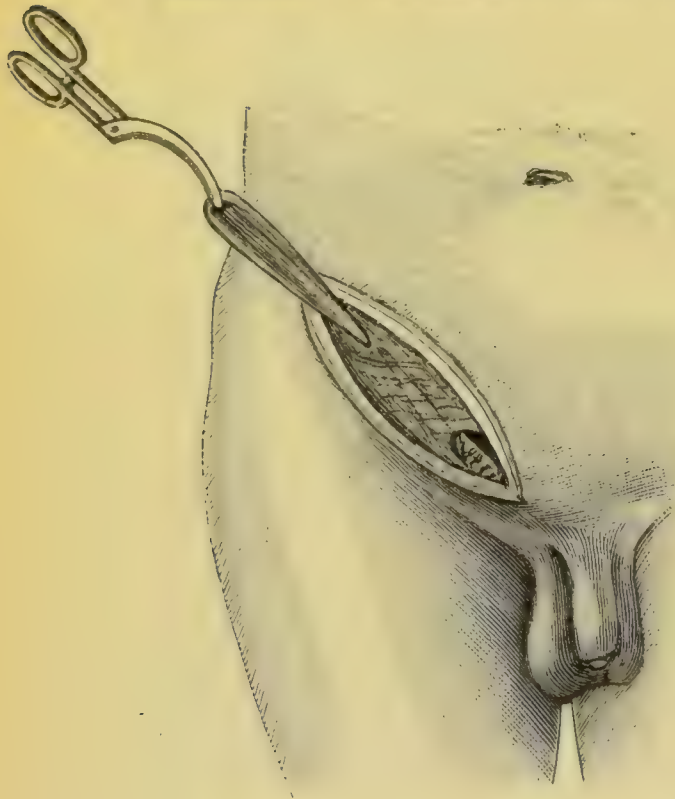


FIG. 487.—Kocher's operation for inguinal hernia.

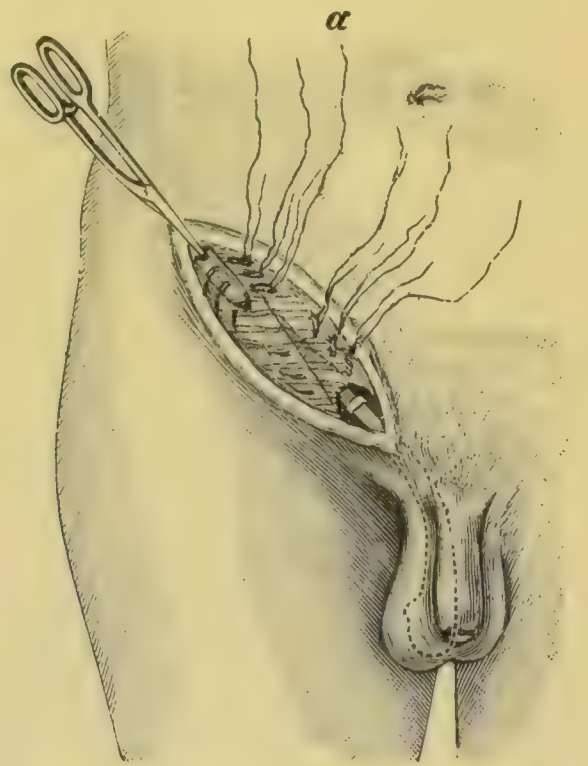


FIG. 488.—Kocher's operation for inguinal hernia.

same side by palpation or by drawing them outward and extirpate them as necessity may require. The radical operation itself is performed according to one of the above-given methods.

Recurrences after a radical operation are most likely to take place, aside from those cases in which a poor method is chosen, when the wound does not heal by primary union. It is not so much the method as it is the good technique of the operator which is the main factor in avoiding a recurrence.

For other methods which have not been mentioned here, see the different forms of hernia.

Under the protection of asepsis the radical operation is not a dangerous one. Wood found three deaths in two hundred cases. Permanent cures are most frequent from the use of Macewen's, Bassini's, Kocher's, and Küster's methods.

Should the patient wear a truss after the wound made by the operation has healed? I do not order a truss. I have noticed that the cicatrix atrophies too rapidly in consequence of the pressure, if one is worn, and that it is therefore better to dispense with it. In case of recurrence a truss is prescribed or the radical operation is repeated. One advantage is sure to result from every radical operation, and that is that the patient, in case of a recurrence, can hold the hernia back by means of a truss, whereas that may not have been true before the operation.

In order to bring about cicatricial contraction and thereby a narrowing or closure of the hernial ring, absolute alcohol, tincture of iodine, a concentrated solution of common salt, etc., have been injected near the ring (Schwalbe). The hernia is reduced, the left forefinger is passed into the ring, and then, under guidance of the finger, fifty to eighty per cent alcohol is injected by means of a hypodermic syringe. Care must be taken not to inject the alcohol into a vein, which may produce disastrous results. The opinion of surgeons is much divided as to the value of these hypodermic injections. I have had good results from the method, and have accomplished permanent cures, as have A. Schmidt, Steffen, and others, especially in treating umbilical herniæ in children (one or two injections with a hypodermic syringe about once a week, using fifty to seventy per cent absolute alcohol with sterilized water, under antiseptic precautions). I have never injected more than five cubic centimetres at one sitting in treating adults. The injections must be continued for some time. This method is especially suited for treatment in dispensaries.

To summarize briefly what has been said above, one should, according to the prevailing opinion at present, perform a radical operation upon a hernia according to one of the above-described methods in the following cases: 1. After herniotomy has been performed upon a strangulated hernia when no complications (inflammation, gangrene of the intestine, etc.) exist. 2. In irreducible herniæ which do not permit the wearing of a truss. 3. In very large herniæ with a correspondingly large ring which can not be completely held back by a truss. One must be careful in performing the operation upon old or very feeble persons, and should not undertake it without urgent reasons. A permanent cure can never be guaranteed, but the technique of the operation is so well developed at present that it is secured in a large majority of cases, and if a recurrence does occur the hernia can be held back by a truss.

§ 187. **The Different Forms of Hernia.—Umbilical Hernia.**—By umbilical hernia is understood the protrusion of viscera through the umbilical ring.

Congenital Umbilical Hernia.—In congenital umbilical hernia the protruding viscera lie within the umbilical cord without a covering of peritonæum. The contents almost always consist of intestine. These herniæ into the umbilical cord are not herniæ proper, but are due to a fissure in the abdominal wall. An opening, varying in size, is found at the umbilical ring, but there is no hernial sac caused by protrusion of the peritonæum. The insertion of the umbilical cord upon the abdominal wall is usually funnel-shaped. If such a broad insertion of the umbilical cord into the abdominal wall is found in a newborn child, an examination should be made with reference to the existence of a congenital umbilical hernia. Should there be such a hernia, the contents of the umbilical cord are carefully replaced inside the peritoneal cavity and the cord then tied off. In cases where such herniæ were not recognised, intestine has repeatedly been tied off with the cord, giving rise to a fæcal fistula (see also § 154, page 11). Very large congenital umbilical herniæ have sometimes been observed containing the larger part of the intestines, the stomach, and the spleen. Such children usually die very soon after birth. As already mentioned on page 11, complete segmentation of portions of the intestine occurs within the umbilical cord in rare cases, so that children are then born with corresponding defects of the intestine.

Umbilical Hernia in Children.—Umbilical hernia often appears in the first six months after birth. The earlier the umbilical hernia develops after the birth of the child, the more rapidly does it increase in size, and the later its appearance the smaller it is. Umbilical herniæ among children develop usually in consequence of increased intra-abdominal pressure—e. g., from excessive screaming or coughing, or from phimosis. It is most common in weakly children. The hernial swelling is usually conical or spherical in form. Its reduction is easy, and one then distinctly feels the edges of the ring, which varies in size. The coverings of the umbilical hernia in children are the same as in adults—that is, they consist of the skin, the subcutaneous cellular tissue, the fascia, which is usually very thin, the properitoneal cellular tissue, and peritonæum. In large umbilical herniæ there is sometimes above and below a diastasis of the recti muscles, so that abdominal viscera may protrude here also from the peritoneal cavity.

Umbilical hernia in adults develops in a very large majority of cases during the first months of life. Those that develop later in life occur especially among women in consequence of pregnancy. The size of umbilical herniæ in adults varies greatly. The hernial ring is sometimes very small and sometimes very large. These herniæ may be as large as a man's head or even larger, especially among very fat

people with a pendulous abdomen, and the ring may be so large that one can push his fist through it into the peritoneal cavity.

The hernial contents consist most frequently of omentum and small intestine, also of transverse colon. Davis reported a case of a woman in the ninth month of pregnancy in which a portion of the uterus lay in the umbilical hernia. In very rare cases two separate umbilical herniæ have been observed (A. Cooper).

The coverings of an umbilical hernia consist, as has been said, of skin, subcutaneous cellular tissue, fascia, properitoneal cellular tissue, and peritonæum or the hernial sac. The thickness of the skin and the subcutaneous cellular tissue is very variable, and all the coverings are often extremely thin. The umbilicus is usually found upon the convexity of the hernia, and is often obliterated. It sometimes lies alongside the hernia, or above or below it, so that one is led to suppose that it is a case of hernia of the linea alba above or below the umbilicus. The sac is often covered with abundant fat. This increase in the amount of fat is sometimes a cause of hernia, as it tends to draw the peritonæum outward.

Adhesions often form between the hernial contents and the sac, especially in large umbilical herniæ. The hernia thus becomes irreducible, and strangulation easily occurs. Persons thus affected must be particularly on their guard against errors of diet and inflammation of the gastro-intestinal tract. Strangulation of umbilical herniæ scarcely ever occurs in children.

The diagnosis of umbilical herniæ in children is easy. In congenital umbilical herniæ the funnel-shaped insertion of the umbilical cord is particularly to be noticed, and the intestine can be seen through the transparent amnion covering of the cord.

The diagnosis of umbilical herniæ in adults is likewise easy, and yet abscess of the liver, dropsy and empyema of the gall bladder, gallstones, and carcinoma of the transverse colon have been mistaken for irreducible or strangulated umbilical herniæ and operated upon as such.

Treatment of Umbilical Hernia.—In case of congenital umbilical hernia, treatment consists in returning the contents of the umbilical cord into the peritoneal cavity and tying off the cord. The latter is then covered with an antiseptic dressing, and slight pressure applied to the umbilical region until the umbilicus has sufficiently contracted with the increasing development of the child.

Umbilical hernia in young children should be treated as early as possible, because a permanent and complete cure is then more likely to be secured. The hernia can usually be held back with strips of adhesive plaster. A little pledget of gauze filled with wadding or a piece

of adhesive plaster folded together may be used as a pad to cover the hernial ring. These improvised pads must, of course, project sufficiently on all sides beyond the edges of the ring. If too small a pad is laid into the orifice, like a cork in the mouth of a bottle, the ring becomes enlarged thereby, and its closure by adhesion of the edges is prevented. After reduction of the hernia the ring is closed with the fingers of the left hand; the pad is applied with the right hand and firmly held in position by laying over it a piece of adhesive plaster about as large as the palm of the hand. This piece of plaster is then fastened on by several strips of the same material, about two finger breadths in width, which are applied circularly about the abdomen so that they half cover each other. For the first few days a gauze bandage is also applied over the dressing of adhesive plaster, in order that the latter may adhere completely to the abdominal wall. The dressing must usually be renewed every week or fortnight. This adhesive-plaster dressing is very effective, but parents unfortunately often lack the necessary patience, and a complete cure is not accomplished. I have used of late, with good results, injections of fifty to seventy per cent alcohol (about one injection a week with a hypodermic syringe; see also page 201). Any associated conditions which interfere with the cure of the umbilical hernia, especially bronchitis, constipation, diarrhœa, phimosis, etc., should receive proper treatment.

In case of reducible umbilical herniæ in adults a truss should be worn. Special care must be taken that the trusses do not become displaced—a difficult matter frequently when it is desired not to exert a strong pressure. The best trusses for umbilical herniæ consist of a pad and an elastic belt, with shoulder and thigh straps to prevent them from slipping. Elastic abdominal bandages made to suit the special case, with a pad on the inside, are also very serviceable, as are large pads of leather softly cushioned. In irreducible umbilical herniæ suspensory sacs are used—e. g., suspensory bandages of fenestrated texture, with an elastic belt and shoulder straps like ordinary suspenders. These suspensories should exert a uniform pressure upon the hernia, and thus prevent more viscera from entering the sac.

In case of strangulation of an umbilical hernia, taxis should be tried at first, as described in § 185, page 190. The hernial contents lying near the ring should be reduced first. In a large hernia it is a good plan to grasp the base, draw it forward, and at the same time exert a moderate pressure.

If taxis does not accomplish the purpose, or is contra-indicated on account of too long continuance of the strangulation, or because of already existing complications (inflammation of the hernia, gangrene of

the intestine, peritonitis, etc.), the performance of herniotomy is indicated (for the latter, see § 185, pages 192–195).

Herniotomy for strangulated umbilical hernia is scarcely ever performed upon children, but only as a rule upon adults. Uhde tabulated one hundred and thirty-seven cases of strangulated umbilical hernia, all of which were in adults. The coverings of umbilical herniæ are often so thin and are at the same time so adherent to one another that, upon raising a fold of skin, all the layers of tissue that cover the hernia are included. It is a good plan in such cases to divide the fold of skin by transfixing it at its base, the back of the knife being directed toward the hernial contents; or one may begin the incision above the hernia in the linea alba, and then prolong it downward. The skin incision usually runs longitudinally from above downward. After opening the hernial sac, its contents are carefully examined, especially a strangulated intestinal loop. It is often unnecessary to enlarge the ring. In large umbilical herniæ strangulation is frequently not at all conditioned upon too small a ring, but upon volvulus or upon flexion of the intestine in consequence of bands. This is another reason for carefully inspecting the hernial contents in large umbilical herniæ. If, however, the strangulation is occasioned by too small a ring, the latter is enlarged preferably in a downward direction or at the left upper part of the circumference of the ring. There are no important structures in the circuit of the latter, and one may therefore enlarge it in whatever direction is most convenient. In exceptional cases an umbilical vein is found to persist. One will, if necessary, enlarge the ring, not by a single large incision, but by several smaller ones, because in the former case difficulty may arise in the retention of the abdominal viscera after their reposition.

As regards the remaining technique of herniotomy in connection with strangulated umbilical hernia—e. g., in case of threatened or already existing gangrene of the intestine—and for the method of making an artificial anus, etc., the reader is referred to § 185, pages 192–195, where all these matters were more fully discussed.

The different methods of radical operation for inguinal hernia described in § 186, page 196 ff.—e. g., those of Macewen, Barker, and others—are also applicable to umbilical hernia. Lawson Tait, Sängner, and others have cured umbilical herniæ by splitting the edges of the ring into two layers by horizontal incisions one centimetre deep and parallel to the peritonæum, and then suturing the broad wound surfaces thus obtained with silk. I have obtained very good results by excision of the umbilicus, longitudinal splitting of the inner margin of the sheaths of both rectus muscles, and subsequent suture of the ab-

dominal wound by layers. The peritonæum is first united by a continuous suture, then the two rectus muscles, the anterior sheaths of the latter, and finally the skin.

§ 188. **Ventral Herniæ.**—Herniæ may appear at different parts of the abdominal wall. Median ventral herniæ are confined to the linea



FIG. 489.—Ventral hernia (in the linea alba) two years after an ovariectomy.

alba, and lateral ventral herniæ to the outer border of the rectus or the region of the external or internal oblique muscles. According to Linhart, Lücke, and others, ventral herniæ may also develop at the site of large dilated openings for the vessels. Lumbar hernia occurs between the twelfth rib and the crest of the ilium. Gourdon and Grimard made the interesting observation that ventral herniæ are noticeably frequent in old persons with scoliosis, on account of the atrophy of the abdominal and lumbar muscles.

Ventral herniæ are most commonly found in the median line, and arise, as a rule, from stretching of the cicatrix after laparotomy, when no abdominal bandage is worn. These ventral herniæ following laparotomy may reach a large size (Fig. 489), and the rectus muscles are often separated to such an extent that one can push the whole fist into the peritoneal cavity between them. Other herniæ in the median line arise usually from the fact that a gap is formed in the linea alba, either gradually or more suddenly, in consequence of a traumatism, and the peritonæum is pushed

through this orifice, forming a hernial sac. These median ventral herniæ usually lie near the umbilicus, above and below it, so that they might almost be taken for umbilical herniæ. Small herniæ not infrequently appear between the ensiform process and the umbilicus (epigastric herniæ), which may cause marked disturbances (pain, especially on pressure or bending over and after eating, vomiting, loss of flesh, neurasthenia), as in diseases of the stomach (Bergmann, König, O. Witzel). They are usually found in a tendinous intersection of the rectus muscle, and generally consist of omentum. The pain is conditioned upon traction on the omentum. The best treatment is operation.

The other herniæ of the abdominal wall—that is, the lateral ventral herniæ and the lumbar herniæ—are rare. In Fig. 490, A represents a lumbar hernia (after an observation of Julius Wolff). Its ring, situated in Petit's triangle, is shown in Fig. 490, B. This triangle is bounded in front by the external oblique muscle, behind by the latissimus dorsi, below by the crest of the ilium, while its floor is formed by the internal oblique. Larrey collected from literature twenty-six cases of this rare form of hernia. H. Braun and Julius Wolff have recently occupied themselves with a more exact study of lumbar hernia.

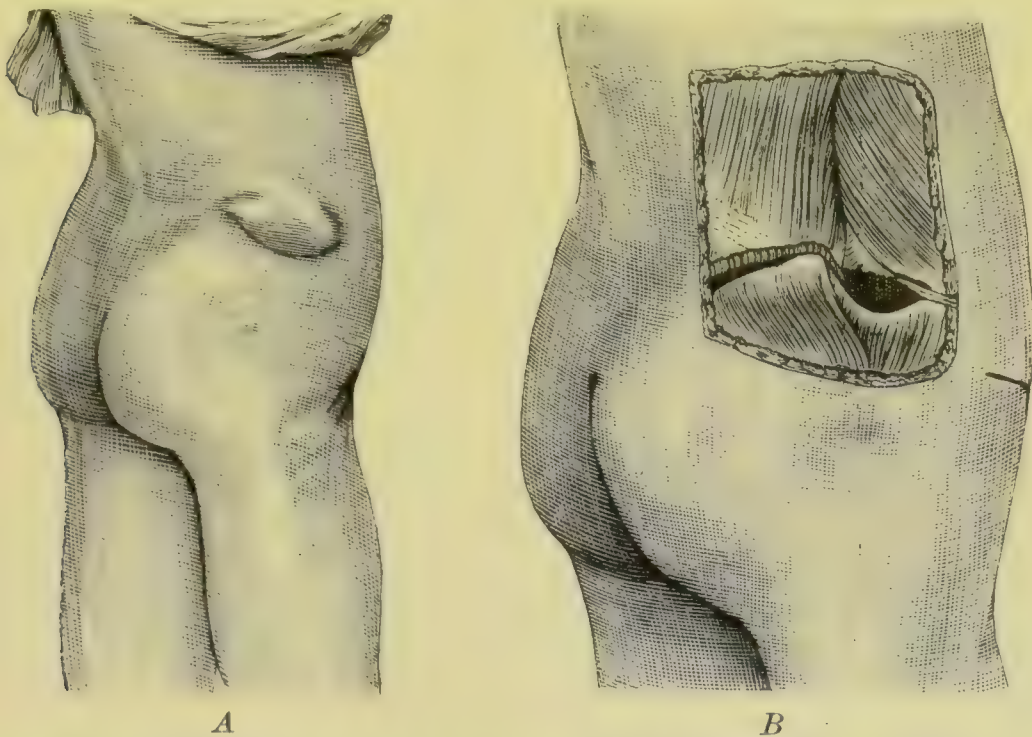


FIG. 490.—Lumbar hernia about the size of a goose egg in a shoemaker twenty-four years of age which had developed after chronic suppuration of the ilium; B shows the hernial ring.

H. Braun, after an observation of his own, collected from literature twenty-nine cases. Twenty of these were congenital or had developed spontaneously, and in nine cases there was a history of traumatism. The hernia does not always protrude through Petit's triangle, and the latter is not perfectly constant. In Braun's case of lumbar hernia, for example, this triangle did not exist. Braun thinks that the more or less large openings filled with fat and connective tissue within the aponeurotic origin of the latissimus-dorsi muscle, which serve for the passage of cutaneous nerves, may, under certain circumstances, occasion lumbar herniæ. There exists, on the other hand, according to Hartmann, in the region of the upper angle of Petit's triangle between the internal oblique muscle and the deep, long muscles of the back, a strikingly thin, yielding place, through which a hernia can easily pro-

trude. Spinal abscesses following spondylitis and caries of the pelvis, or injuries, sometimes precede the formation of the hernia. The stretching of the abdominal muscles in consequence of pregnancy seems only rarely to have occasioned a lumbar hernia. Petit has reported the only case of this kind. Lumbar herniæ have in some cases given rise, as regards diagnosis, to fatal errors. In view of the small number of cases of lumbar hernia that have as yet been thoroughly investigated, they are not at present fully understood as regards their ætiology and anatomy.

It may be added that intercostal herniæ—e. g., between the seventh and eighth ribs—have been observed after punctured wounds of the lower intercostal spaces (Cloquet, Risel). See also *Hernia of the Lung*, vol. ii, § 115, page 660.

The ætiology of all ventral herniæ may be briefly summarized in the statement that they are occasioned primarily by all those pathological conditions and traumatisms which lessen the resistance of the abdominal wall—that is, a laparotomy cicatrix, suppuration of the abdominal wall or the pelvis, a spinal abscess, or by degeneration of the abdominal muscles. A portion of the ventral herniæ arises, as we saw, from injuries—e. g., from subcutaneous ruptures of tissue, punctured wounds, etc. If the peritonæum is torn by the injury, a hernial sac may be wanting, and we have then to do, strictly speaking, not with a genuine hernia, but merely with a prolapse of abdominal viscera. Ventral herniæ are occasionally caused by properitoneal collections of fat which, with their increasing growth, draw the peritonæum outward more and more in the form of a pouch. We have already said above that herniæ also protrude through dilated openings in the abdominal wall for the passage of vessels.

Treatment of Ventral Herniæ.—In treating ventral herniæ, elastic belts with a pad are used just as in umbilical herniæ. A well-fitting elastic abdominal bandage should be worn as a matter of precaution after a laparotomy, in order that stretching of the cicatrix may be prevented as far as possible. In irreducible herniæ hollow pads may be used as a protection when, for example, the hernia is sensitive to friction or to the touch. Strangulated ventral herniæ are treated in accordance with general rules (see § 185, page 189 ff.), and the radical operation should also be performed, in suitable cases, according to the general directions given in § 186, page 195 ff. I cured a very large hernia of the linea alba resulting from an ovariectomy by the following method, first recommended by Simon :

The edges of the hernia are first freshened in the way shown in Fig. 491, by removing two strips of skin and subcutaneous cellular tissue about two centimetres in width over the two rectus muscles, which are separated from one another. The two inner edges of the

oval are then united longitudinally by a continuous catgut suture, the hernial sac being folded inward in this way together with its cutaneous covering. The wound is finally united with deep and superficial silk sutures (Fig. 492). I made liberating incisions on each side about five centimetres from the wound, extending deep into the subcutaneous cellular tissue, and covered them with skin-grafts. I inserted a short drainage-tube into the hernial sac which had been infolded, in order to keep the lower angle of the cutaneous sac open and to provide an escape for the sweat. The result



FIG. 491.—Operative treatment of ventral hernia: denudation of the skin.

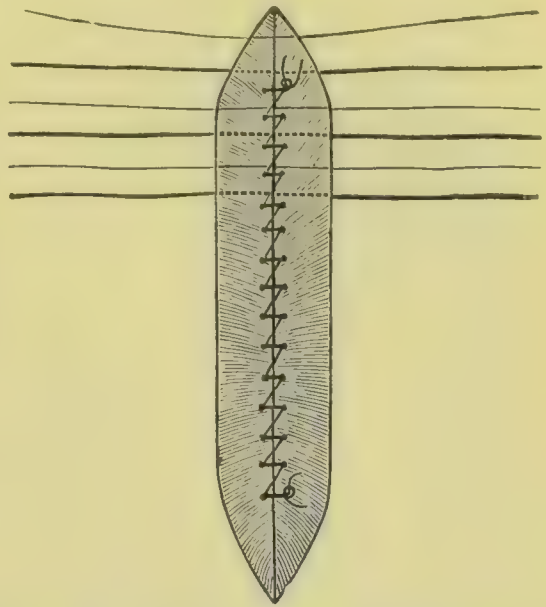


FIG. 492.—Operative treatment of ventral hernia: union of the two inner edges of the wound shown in Fig. 491 and suture of the denuded surfaces.

was excellent and permanent. The wound healed by primary union. In suitable cases one may perform a more radical operation—i. e., open the peritoneal cavity, detach the peritonæum laterally and unite it by suture, and then, after splitting the sheaths of the recti longitudinally, push the latter over one another and unite them with silk or silver wire so as to form a single muscular plane. The fascia and skin are then united separately.

The other varieties of ventral hernia should likewise be treated by a radical operation. One may, in case of large herniæ, fold the sac up in the form of a pad and place it inside the hernial ring (Macewen; see pages 197, 198). As is true of all radical operations for hernia, the prognosis of operations upon ventral herniæ is very favourable. O. Vulpius has tabulated seventy-two cases of ventral hernia which were operated upon since the adoption of antiseptic methods. There was not a single fatal case.

§ 189. **Inguinal Hernia.**—This is the commonest form of rupture. The inguinal canal contains in the male the spermatic cord, which passes from the scrotum into the peritoneal cavity and in the female the round ligament. Two main forms of inguinal hernia are distinguished—the external or oblique, and the internal or direct (Fig. 493).

The oblique inguinal hernia passes through the entire length of the inguinal canal, pushing before it the loose cellular tissue about the spermatic cord and within the infundibuliform fascia. It enters the internal ring to the outer side of the

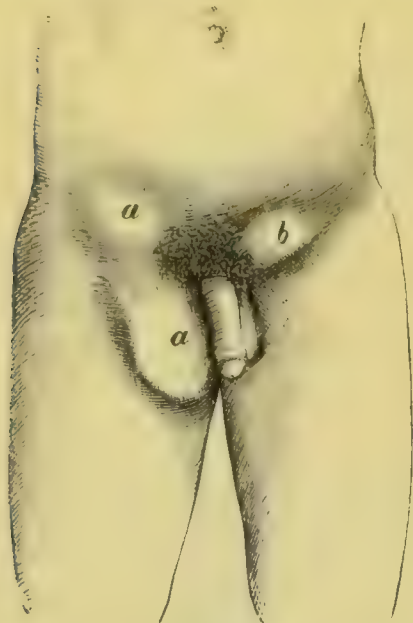


FIG. 493.—Inguinal hernia: *a a*, oblique inguinal hernia (scrotal); *b*, direct inguinal hernia.

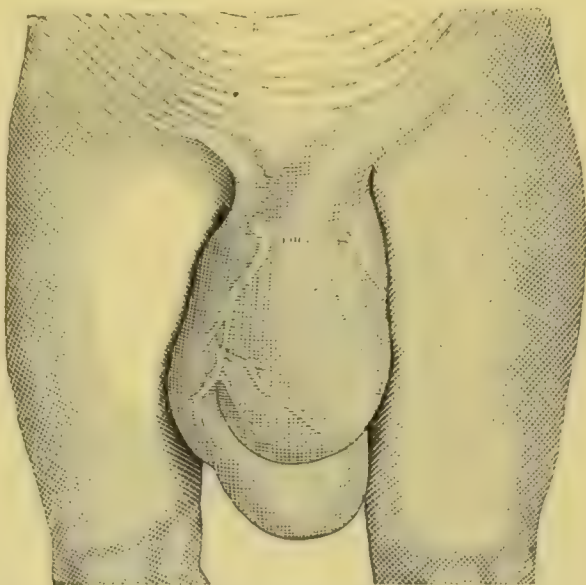


FIG. 494.—An unusually large labial hernia in a woman twenty-nine years of age.

epigastric artery, and then emerges through the external ring and descends into the scrotum (scrotal hernia), or, in the female, into the labia majora (labial hernia). Labial herniæ sometimes reach an enormous size (Fig. 494, from a case in Lücke's clinic).



FIG. 495.—Properitoneal hernia (Krönlein).

Oblique inguinal herniæ sometimes remain in the inguinal canal, and are then called bubonocœles. One variety of the latter is the properitoneal hernia (Fig. 495), which passes from within the inguinal canal between the peritonæum and the transversalis fascia, so that it lies in front of the parietal peritonæum. It occurs almost exclusively among men. Among

fifty-four cases tabulated by R. Butz, only one was in a woman. The development of the properitoneal hernia has been very variously explained. There is usually a pre-existing anomaly of the peritonæum—e. g., a diverticulum of the same (Brunner, Kaufmann), an ab-

normal closure of the processus vaginalis or an undescended testicle (Trendelenburg, Butz, Bramann, and others; see also page 212, Development of the Inguinal Canal). Hydrocele of the spermatic cord may after rupture of the septum between the hydrocele and the abdominal cavity occasion the formation of a diverticulum, into which intestine may enter (M. Schmidt). We have already seen (pages 191, 192) that a properitoneal hernia may also arise from detachment of the peritonæum from the transversalis fascia, owing to violent taxis, and from reduction *en masse* of a strangulated inguinal hernia. Aside from this properitoneal hernia in the inguinal region, there is also one in the femoral region, but this is much rarer. Among thirty cases of properitoneal hernia collected from literature, Krönlein found but one in the femoral region.

Direct or internal inguinal hernia (Fig. 493, *b*) passes, on the inner side of the epigastric artery, directly through the external ring, pushing the transversalis fascia before it. Direct inguinal hernia is much rarer than the oblique. The point of exit of both kinds of inguinal hernia or their location in the peritoneal cavity is most clearly understood by looking at the lower part of the abdominal wall from the inside (Fig. 496). Three more or less distinct peritoneal folds are here seen: First, the median vesico-umbilical fold, or the median suspensory ligament of the bladder, extending from the summit of the bladder to the umbilicus. This is the obliterated urachus (Fig. 496, 1). Second, on each side the lateral vesical ligament, or the lateral vesico-umbilical fold, extending from the side of the bladder to the umbilicus. This is the obliterated umbilical artery (Fig. 496, 2). Third, the epigastric fold, answering to the course of the epigastric artery and vein (Fig. 496, 3). Laterally from each of the three folds named there is a corresponding depression. To the outer side of the median suspensory ligament of the bladder is the internal inguinal fossa (Fig. 496, *a*). It lies between the ligament just named and the lateral vesico-umbilical fold (or lateral vesical ligament). Between the latter and the epigastric fold lies the middle inguinal fossa (Fig. 496, *b*), and to the outer side of the epigastric fold the external inguinal fossa (Fig. 496, *c*), in which the internal opening of the inguinal canal (Fig. 496, R) is situated. The internal and the middle inguinal fossæ form the points of exit of direct or internal inguinal herniæ. Linhart also distinguished the internal from the middle inguinal hernia, answering to the internal and middle inguinal fossæ, but this distinction can not be maintained clinically. Herniæ rarely protrude through the internal inguinal fossa (Fig. 496, *a*). Most direct herniæ emerge through the middle inguinal fossa between the epigastric and the lateral vesico-umbilical folds.

Anatomy of the Inguinal Canal.—The internal abdominal ring, semilunar in form, is situated in the transversalis fascia, and is covered by the properitoneal fat and the peritonæum. The external ring is situated between the longitudinal fibres of the external oblique aponeurosis. The thin, funnel-shaped continuation of this aponeurosis on to the spermatic cord is called the intercolumnar fascia. The posterior wall of the inguinal canal

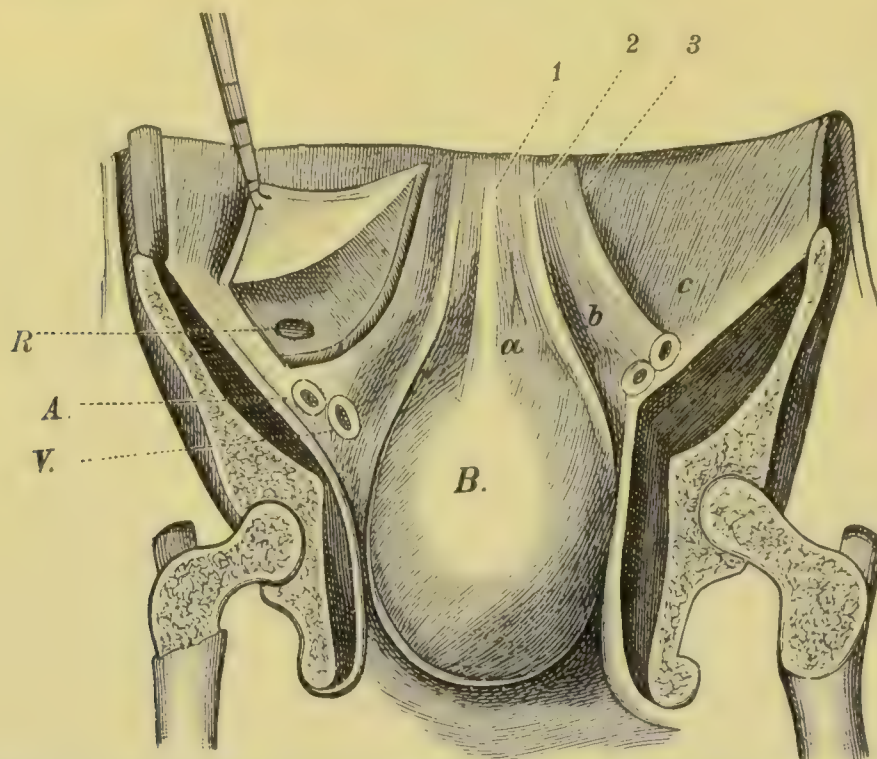


FIG. 496.—Posterior view of the abdominal wall after removal of the sacrum: *B*, bladder; *A*, femoral artery; *V*, femoral vein; *R*, internal ring. On the left side the peritonæum is detached in the form of a triangular flap; the epigastric artery lies to the inner side of the internal ring; *1*, middle vesico-umbilical fold (obliterated urachus); *2*, lateral vesico-umbilical fold; *3*, epigastric fold (epigastric artery); *a*, internal; *b*, middle; and *c*, external inguinal fossa.

is formed by the transversalis fascia as far as the sheath of the pyramidalis muscle, the anterior wall by the aponeurosis of the external oblique, and in its outer third by the internal oblique and transversalis muscles. The lower wall corresponds to Poupart's ligament. An upper wall proper does not exist. The lower arched border of the internal oblique and transversalis muscles may be regarded as such. Of the vessels in the vicinity of the inguinal canal, the inferior epigastric artery near the internal abdominal ring is the most important, which gives off the external spermatic artery, and this in turn perforates the posterior wall of the inguinal canal and passes into the spermatic cord. The superficial epigastric vessels are found in the subcutaneous connective tissue. The superficial circumflex iliac artery and vein are of more importance for femoral herniæ, as are the femoral artery and vein below Poupart's ligament.

The development of the inguinal canal is intimately connected with the descent of the testicle from the peritoneal cavity into the scrotum, and, in females, with the change of place of the ovary. The testicles and the ovaries, covered with peritonæum and provided with a short mesentery, the mesorchium, are situated at the outset in the peritoneal cavity near the lumbar

vertebræ on the anterior and inner side of the Wolffian body. The blood-vessels run transversely from the aorta and to the inferior vena cava.

In the male foetus the testicle gradually moves downward. In the third month it already lies distinctly lower. Before the further descent of the testicle into the scrotum the peritonæum pushes itself through the abdominal wall and down into the scrotum, forming the so-called processus vaginalis (Fig. 497, P. v.). The inguinal canal is formed by this protrusion of the peritonæum previous to the descent of the testicle. Simultaneously with the development of the processus vaginalis, the transversalis fascia of the abdominal wall, and some fibres of the lateral abdominal muscles, are protruded. From the former arises the infundibuliform fascia, and from the latter the cremaster. The aponeurosis of the external oblique muscle is still unperforated prior to the descent of the testicle (Bramann). At the same time the gubernaculum testis is formed, which passes down within the processus vaginalis into the scrotum (Fig. 497, G. H.). The gubernaculum belongs originally to the Wolffian body, and extends from the excretory duct of the same directly downward to the inguinal region. The gubernaculum appears as soon as the testicle begins to enlarge. It consists, according to A. Kölliker, of fibrous tissue with striated and non-striated muscular fibres. The former originate from the abdominal muscles.

After the processus vaginalis and the gubernaculum testis have developed in the manner just described, the

testicle passes with its covering of peritonæum, the gubernaculum being gradually shortened, as far as the orifice of the processus vaginalis (Fig. 497) enters it, usually in the seventh month, and finally makes its way into the scrotum, passing through the entire inguinal canal. The gubernaculum disappears without leaving a trace. According to A. Kölliker, however, the so-called inner muscular coat of the testicle between the tunica vaginalis and the infundibuliform fascia is really the remains of the gubernaculum testis.

It is clear, from the mode of descent of the testicle, which has just been described, why the latter must have a double covering of peritonæum—viz., the one that it brings with it from the peritoneal cavity, and also the protruded peritonæum, the processus vaginalis. These two layers form later the tunica vaginalis testis. The descent of the testicle is usually completed at birth, but in exceptional cases one testicle or the other remains in the inguinal canal, or even in the peritoneal cavity (cryptorchismus). If the descent of the testicle is completed in the normal manner, the processus vaginalis is in open communication with the peritoneal cavity at the time of birth. It very soon obliterates, however, forming a fibrous cord, the so-called ligamentum vaginale. Various abnormalities may occur in connection with this closure of the processus vaginalis of the peritonæum, the chief of which is that it may remain partly or completely open. If it remains open in its

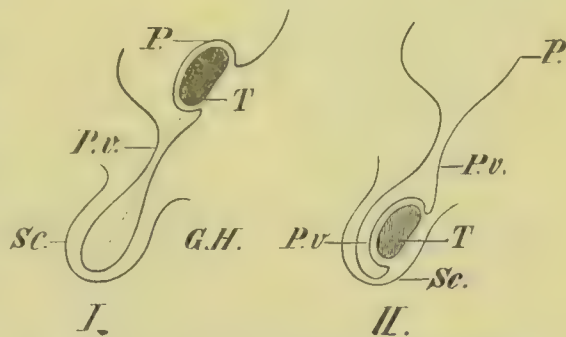


FIG. 497.—Descent of the testicle (diagrammatic): I, testicle at the orifice of the processus vaginalis; T, testicle; P, peritonæum; P. v, processus vaginalis; Sc, scrotum; G. H, Hunter's gubernaculum; II, testicle inside the scrotum (H. Kölliker).

entire extent, viscera can descend as far as the testicle, and a congenital testicular hernia is the result. If the processus vaginalis is closed only above the testicle, a congenital hernia into the funicular process results. A further variety of congenital hernia is the encysted hernia, which occurs when the processus vaginalis is occluded only in the inguinal canal and a sac is formed

above, which is invaginated into the tunica vaginalis below, thus giving rise to a sac within a sac.

If the processus vaginalis remains partially open, there result also the various forms of hydrocele or serous collections in the region of the spermatic cord and in the tunica vaginalis (see Hydrocele).

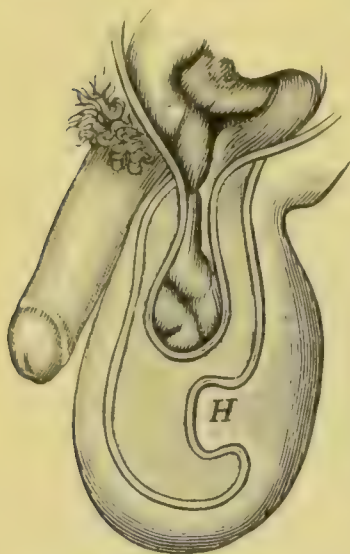


FIG. 498.—Congenital encysted hernia (diagrammatic).

The descent of the ovary in females is less distinctly marked. The ovaries lie in the foetus, at the outset in the same place as the testicles, and are likewise covered with peritonæum. The processus vaginalis and the inguinal canal are also formed in the female sex in the same way as described above. There is also a gubernaculum, which becomes later the round ligament of the uterus. The processus vaginalis of the peritonæum, also called the canal of Nuck, disappears later without leaving a trace. The ovaries likewise descend, with the disappearance of the Wolffian bodies toward the inguinal region, and

the peritoneal covering of the Wolffian body becomes the broad ligament of the uterus. The ovaries do not reach the true pelvis until the end of the embryonic life. In very rare cases the ovary, like the testicle, has been found, upon one or both sides, in the inguinal canal or even in the labia majora.

The descent of the genital glands is difficult to explain. Various hypotheses have been advanced. As the presence of muscular fibres in the gubernaculum has been demonstrated, it has been said that the testicle is drawn down by the contraction of the gubernaculum. According to A. Kölliker, the gubernaculum only determines the direction, while the change of place of the testicle, as well as of the ovary, may be conditioned really upon the more rapid growth of the parts located above the genital glands, and the less marked increase in size or the contraction of the parts located below them.

Symptomatology and Diagnosis of the Different Varieties of Inguinal Hernia.—We have become acquainted with the following forms of inguinal hernia: 1. The oblique inguinal hernia, which enters the inguinal canal through the internal ring and then descends through the canal into the scrotum, it may be, or, in females, into the labia majora. Every scrotal or labial hernia is an indirect inguinal hernia. The epigastric artery lies on the inner side. Varieties of this external inguinal hernia are the incomplete or so-called bubonocoele which remains in the inguinal canal, and the properitoneal hernia (Krönlein) which passes from within the inguinal canal into the abdominal wall, so that it lies between the peritonæum and the transversalis fascia. 2. The

direct inguinal hernia which pushes before it the transversalis fascia, forming the posterior wall of the inguinal canal, and emerges from the external ring without passing through the whole length of the inguinal canal. The direct inguinal hernia remains, as a rule, near Poupart's ligament, and can never become a scrotal or labial hernia; still, large direct inguinal herniæ sometimes descend so far that it is difficult or almost impossible to distinguish them from oblique inguinal herniæ. In direct inguinal hernia the epigastric artery lies to the outer side. 3. We have become acquainted with the congenital inguinal hernia in its different forms. We have seen that in congenital scrotal herniæ the hernial contents usually lie together with the testicle in the processus vaginalis which has remained wholly open. As special varieties of congenital hernia we have also mentioned (page 214) hernia into the funicular process and encysted hernia.

Inguinal hernia, whose development is favoured by the above described formation of the inguinal canal and the permanently diminished resistance in the inguinal region even after normal closure of the processus vaginalis, is observed most frequently among men. It is in general the most common form of hernia. Out of a hundred cases there are about eighty inguinal, ten femoral, and five umbilical herniæ. The oblique inguinal hernia is much more common than the direct. The former occurs mostly in early childhood or youth, while the latter does not develop as a rule until later in life (see page 179, *Etiology of Hernia*).

Oblique inguinal herniæ sometimes reach an enormous size, so that in rare cases they hang down to the knee, for instance, and contain the larger part of the intestinal coils. An especially large oblique inguinal hernia (labial hernia) is represented in Fig. 494, page 210. There are marked disturbances, especially when large scrotal and labial herniæ become irreducible in consequence of adhesions of the hernial contents with the sac.

Direct inguinal herniæ seldom exceed the size of the fist, and become strangulated much less often than the oblique, because in the latter the hernial ring is smaller.

Large inguinal herniæ sometimes contain a portion of the bladder or an ovary. Urinary disturbances usually exist in connection with a hernia of the bladder (cystocele, see *Surgery of the Bladder*, § 206). Reichel observed prolapse of a distended ureter into the inguinal canal in connection with simultaneous hydronephrosis. Englisch tabulated thirty-eight cases of hernia of the ovary. The ovary was found twenty-seven times in an inguinal hernia, ten times in a femoral hernia, and once in an obturator hernia. The characteristic form of the

ovary and its enlargement at the period of menstruation are especially important for the diagnosis of ovarian herniæ. The cæcum and the appendix sometimes lie within an inguinal hernia (see page 178). In very rare instances the duodenum and the pyloric portion of the stomach have been found in scrotal herniæ (Thoman, Chiari).

For the symptomatology of strangulated inguinal herniæ the reader is referred to the general description of strangulated herniæ in § 183, page 185 ff.

The diagnosis of oblique and direct inguinal herniæ should be sufficiently clear from what has been said. The variety of oblique inguinal hernia known as properitoneal inguinal hernia can also be recognised, as a rule, from its situation in the abdominal wall between the peritonæum and the transversalis fascia and above the inguinal canal. As already mentioned, it may be difficult or impossible to decide, in case of a large hernia, whether it is an oblique or a direct inguinal hernia. In fat women the differential diagnosis between inguinal and femoral hernia may be difficult when Poupart's ligament and the spine of the pubes can not be felt. A femoral hernia lies below Poupart's ligament, while the spine of the pubes and the insertion of the external oblique aponeurosis can be felt above the hernial tumour.

As regards the differential diagnosis between inguinal hernia, hydrocele, and varicocele, it may be noted, in the first place, that a hydrocele is incapable of reduction, translucent, dull on percussion, and usually terminates at the external ring, where one distinctly feels the upper end of the tumour. Hydrocele of the spermatic cord is usually circumscribed, and one can determine that it does not, as a rule, continue into the peritoneal cavity. We have only exceptionally to do with a bilocular hydrocele—that is, with one which continues through the inguinal canal into the peritoneal cavity and forms a second swelling inside the latter. A hæmatocele gives much the same symptoms as a hydrocele. For a more detailed description of hydrocele the reader is referred to § 233. Congenital hydroceles may also, it is true, be capable of reposition even at a later age (hydrocele communicans, see § 233). Similar cyst formations, analogous to the hydrocele in man, occur in females in the unobliterated processus vaginalis.

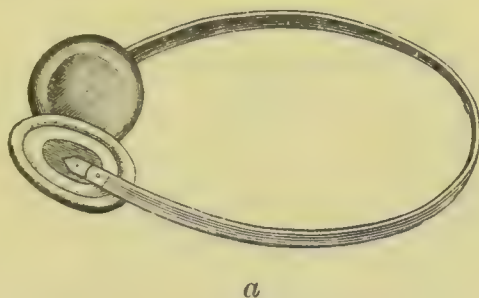
Varicocele—that is, the varicose enlargement of the veins of the spermatic cord—can usually be at once recognised as such, and is scarcely to be confounded with an inguinal hernia. Inflamed inguinal glands, or buboes, can be easily distinguished from an inflamed inguinal hernia, as in the latter there are manifestations of irritation on the part of the peritonæum and possibly symptoms of strangulation. In inflammation of an empty irreducible hernial sac the differential diagnosis is of no consequence, as this would be incised like a bubo. Tumours of the scrotum or the testicle and the spermatic cord scarcely give rise to confusion with inguinal hernia, as they are to be distinguished by their form, their consistence, their growth from a definite place, etc.

The treatment of inguinal hernia conforms to the general principles of treatment of hernia described in § 184, page 188, and § 185,

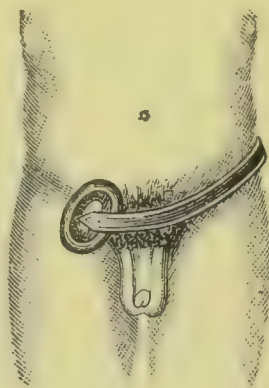
page 189 ff. Reducible herniæ are held back by a proper truss. The German truss encircles the affected side, while the belt is laid about the sound side. It is applied in the way shown in Fig. 499. Displacement of the pad is prevented by the thigh strap which encircles the inner side of the thigh and is fastened to the pad. The English truss (Fig. 500, *a*) encircles the sound side and is applied as shown in Fig. 500, *b*. This truss is more effectual in consequence of its longer lever arm. The pad is united with the spring of the truss by a ball-and-socket joint. It is much more expensive than the German truss. In addition to these two trusses, various other models have been recom-



FIG. 499.—Inguinal hernia held back by a German truss.



a



b

FIG. 500.—*a*, English truss; *b*, the same in position.

mended, but have not been generally adopted. In case of small irreducible herniæ hollow pads may be worn or a radical operation be performed. The reader is referred, for the general rules which are to be observed in the use of trusses, to what was said in § 184, page 188. I will only mention further that, as a matter of precaution, one should prescribe a truss for old people with a weak abdominal wall and a tendency to the formation of a direct inguinal hernia, for instance, in order to prevent the development of such a hernia.

The treatment of large herniæ in cases where the patient has worn no truss for a long time is of especial importance. In order to effect a reduction of the hernia in such cases the patient is made to assume a recumbent position, the coils of intestine are emptied by means of cathartics, and then reduction is attempted in the manner described on page 189. If one only partially succeeds in the reduction of the hernial contents, the remainder of the hernia is enveloped by circular turns of a rubber bandage. The object is gradually accomplished in this way. After complete reposition of the hernia the hernial ring, which is usually large, should be closed by a pad of proper size, or, it may be, by a soft leather cushion attached to the pad. If the hernia is irreducible

and the pain severe, a radical operation is indicated (see § 186, page 195). I recommend especially the methods of Macewen, Barker, Bassini, Kocher, Küster, and the author (see pages 197–200).

Strangulated inguinal herniæ are treated according to the general rules given in § 185, page 189 ff. If taxis is unsuccessful, or if it is contraindicated from the fact that the strangulation is already of too long standing, one proceeds to herniotomy. The reader is referred for the general technique of herniotomy to pages 192–194. Only the following need be added here :

The skin incision should, in the first place, be sufficiently long, especially in a large hernia, in order that one may get a good view of all the conditions and properly inspect the hernial contents. The separate coverings of the hernia are seldom distinguishable as such. The hernial sac is exposed in the manner described on page 192. In inguinal herniæ especially the anomalies of the sac mentioned on page 195 are of importance, because they may give rise to special forms of strangulation—e. g., the hour-glass constriction of the sac and the presence of a diverticulum in the form of a pouchlike protrusion of the hernial sac at its neck. Intestine may be strangulated in such a diverticulum, and if this is overlooked and the remaining contents of the sac are reduced, the strangulation continues, and the patient may die in a very short time from perforation of the intestine and septic peritonitis. The direction of these diverticula varies greatly, but they usually run upward or downward. Such diverticula of the hernial sac filled with intestine commonly admit of easy diagnosis, if one sweeps the finger around the hernial sac or its neck, after reduction of the contents of the sac.

The hernial ring in oblique inguinal herniæ is usually incised in an outward direction on account of the epigastric artery, and in an inward direction in direct inguinal herniæ. Strangulated inguinal herniæ are, however, almost always oblique, so that the ring is usually divided externally. In a possible case of doubt whether one is dealing with a direct or an oblique inguinal hernia, the ring may be enlarged in an upward direction. The ring is, when necessary, divided at several points in an upward and outward direction. The ring should never be incised directly downward. If the epigastric artery is cut, the incision should be enlarged and both ends of the artery tied.

If the strangulation is at the internal ring, it may be necessary, in order not to operate in the dark, to extend the skin incision upward and to divide all the soft parts over the strangulation. In the properitoneal inguinal hernia the strangulation is usually not at the ring, but behind it, in the more or less deeply located neck of the hernial sac.

The contents of the sac should always be carefully inspected, and the degree of the disturbance in nutrition occasioned by the strangulation determined. If the bladder or the ovary is found in an inguinal hernia, they should be replaced after careful disinfection, or the ovary, it may be, removed—e. g., in case of adhesions or atrophy. If one suspects that the bladder may lie in the sac, the diagnosis can be assured by the introduction of a sound.

For the remainder of the technique of herniotomy for inguinal hernia—e. g., in case of doubtful appearance of the bowel or already existing gangrene of the intestine—and for the formation of an artificial anus, see § 185, page 194.

A radical operation is performed after every uncomplicated herniotomy upon reduction of the hernial contents, and also in cases where the hernia, on account of its size or for other reasons—e. g., in consequence of adhesion of the hernial contents with the sac—can not be held back by a truss. Of the different methods described in § 186, those of Macewen, Barker, Bassini, Kocher, Küster, and the author are, judging from my own experience, the best.

In children with a congenital scrotal hernia the sac or the upper portion of the tunica vaginalis, after isolation of the vas deferens and spermatic vessels, is treated either by Macewen's method or the sac or tunica may be tied off high up and the internal ring and inguinal canal closed or narrowed by suture.

In case an inguinal hernia is combined with an undescended testicle (see Surgery of the Testicle) the latter may be pushed through the internal ring into the abdominal cavity or brought down into the scrotum. Nicoladoni used the portion of the processus vaginalis lying behind the testicle and intimately attached to the epididymis as a sort of gubernaculum and sutured it into a skin incision in the perinæum, so that the testicle remained permanently fixed in the scrotum,

§ 190. **Femoral Hernia.**—Femoral hernia emerges below Poupart's ligament through the femoral ring or the septum crurale, and descends along the sheath of the femoral artery and vein, usually to the inner side of the vein, and rarely behind the large femoral vessels or in the sheath itself.

Anatomy of Femoral Hernia.—The anatomy of femoral hernia is very differently described by different authors. We follow here, essentially, the description given by Joessel. Poupart's ligament extends from the anterior superior spine of the ilium to the spine of the os pubis—that is, to the level of the symphysis. At the inner insertion of Poupart's ligament its fibres are reflected downward in the shape of a fan forming Gimbernat's ligament, whose special appellation is somewhat artificial (Fig. 501). The ilio-pectineal ligament passes obliquely downward from Poupart's ligament to the ilio-pectineal eminence on the upper border of the horizontal ramus of the os

pubis (Fig. 501). This ilio-pectineal ligament forms a portion of the deep layer of the fascia lata of the thigh and of the ilio-pectineal fascia. The space between Poupart's ligament and the upper border of the horizontal ramus of the os pubis is divided by the ilio-pectineal ligament into two parts—viz., the lacuna musculorum, which contains the ilio-psoas muscle and the anterior crural nerve, and the lacuna vasorum, which incloses the femoral artery and vein (Fig. 501). The lacuna vasorum is oval in form. It is bounded above by Poupart's ligament, on the inner side by Gimbernat's ligament, on the outer side by the ilio-pectineal ligament, and below and behind by the part of the fascia lata which lies upon the os pubis and is designated as the pubic ligament of Cooper (Fig. 501).

The so-called crural canal in which the large femoral vessels lie is of great importance for the anatomy of femoral hernia. It presents a funnel-shaped

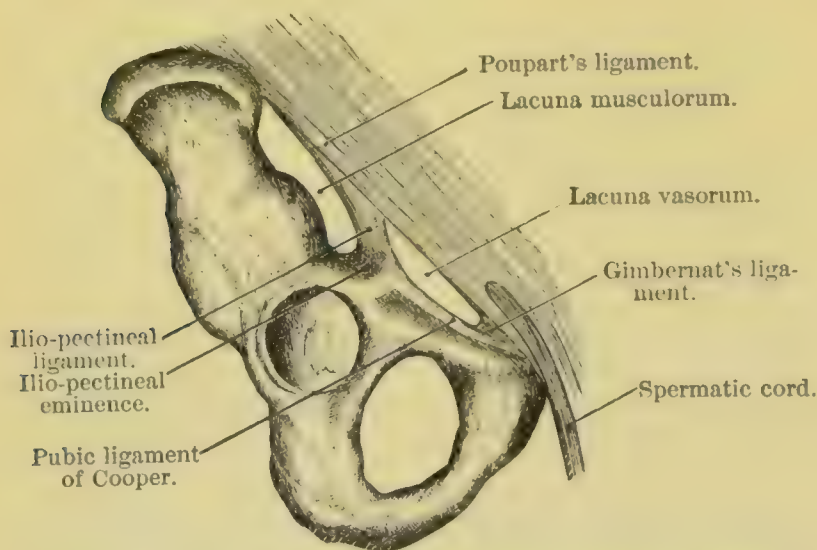


FIG. 501.—Lacuna musculorum and lacuna vasorum (Joessel).

space which extends downward from Poupart's ligament for about three centimetres, and owes its existence to the fact that the superficial layer of the fascia lata passes downward from Poupart's ligament as a covering in front of the femoral vessels, while the deep layer of the fascia lata (ilio-pectineal fascia) passes down behind the large fem-

oral vessels. The two layers of the fascia lata unite about three centimetres below Poupart's ligament, where they surround the vessels more closely and form their common sheath. The two layers of the fascia lata, however, unite not only below but also on the inner side in front of the pectineus muscle and externally in front of the ilio-psoas muscle. This funnel-shaped space thus formed between the superficial and the deep layer of the fascia lata beneath Poupart's ligament is the so-called crural canal (Fig. 502). It is, as has been said, about three centimetres long and ends below where the two layers of the fascia lata unite and inclose the femoral vessels forming their sheath. The so-called femoral ring (annulus cruralis)—that is, the point of entrance of the femoral artery and vein—may be regarded as the upper aperture of the crural canal. Otherwise, it is closed at Poupart's ligament by the parietal peritonæum and a continuation of the transversalis fascia. The saphenous opening is designated as the lower aperture. These are, however, not real openings of the crural canal. Two or three lymph glands lie on the inner side of the femoral vein. The one situated farthest upward, in part behind Poupart's ligament, is Rosenmüller's gland. It indicates the place of exit of a femoral hernia. This uppermost part of the crural canal at Poupart's ligament, between the femoral vein and Gimbernat's ligament, is also

called the septum crurale, and Rosenmüller's gland lies within it (Fig. 502). Linhart calls this place the femoral ring. Otherwise, the crural canal is filled with fat and connective tissue.

The superficial layer of the fascia lata is strikingly thin in front of the femoral vein and to the inner side of the same, is perforated, and its interstices are filled with fat. This part of the superficial fascia lata is therefore called the cribriform fascia. Its extent is very variable. The part of the fascia lata located just below the point of entrance of the internal saphenous vein is of strong tendinous structure. It forms the lower edge of the saphenous opening and has an oval form with its concavity directed upward. This

free border of the fascia lata is called the falciform process. If the cribriform fascia located above the entrance of the internal saphenous vein is removed, there is left a large, deep space in the form of an oval fossa, the so-called fovea ovalis. Femoral herniæ lie in this oval fossa—that is, to the inner side of the large femoral vessels and above the entrance of the saphenous vein (Fig. 503). They reach this place by protrusion of the parietal peritonæum

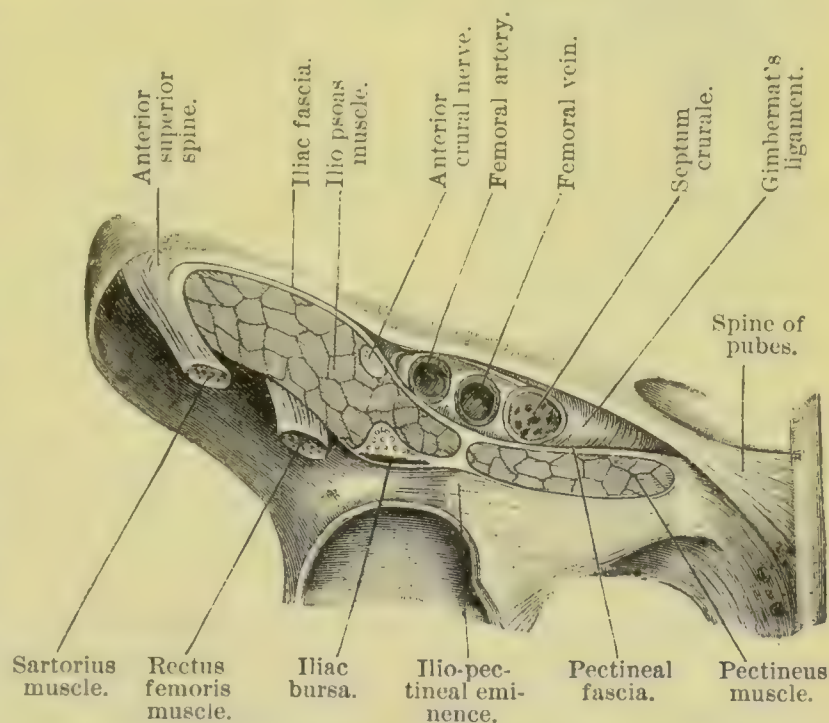


FIG. 502.—Transverse section of the soft parts below Poupart's ligament (Volz).

and the transversalis fascia, in the region of Rosenmüller's gland, between the femoral vein and Gimbernat's ligament (Fig. 502). A femoral hernia has, in addition to the skin and the superficial fascia, two coverings: 1. The cellular tissue that fills the crural canal. 2. The sheath of the vessels. The latter is also called fascia propria herniæ femoralis (see Fig. 503). Besides this usual form, there are the following varieties of femoral hernia:

1. The incomplete femoral hernia, which occurs when the hernia remains inside the crural canal. This hernia may descend for some distance along the vein. In rare cases the hernia lies in front of the vessels, or to the outer side of the artery.

2. A femoral hernia sometimes leaves the crural canal posteriorly and passes through the enlarged apertures for vessels in the deep layer of the fascia lata, covering the pectineus and the ilio-psoas muscles (Vidal, Cloquet).

3. A femoral hernia may protrude through the fibres of Gimbernat's ligament which are forced apart.

4. A hernia may pass through the internal inguinal fossa as a direct inguinal hernia and then make its way into the crural canal.

5. In many cases an ordinary femoral hernia extends upward over Poupart's ligament, so that it may be mistaken for an inguinal hernia.

6. There is also a properitoneal femoral hernia analogous to the properitoneal inguinal hernia (page 210, Fig. 495), which has thus far, according to Krönlein, been described but once. The femoral hernia here also lies in the abdominal wall in front of the peritonæum. Aside from the origin given on page 210, the properitoneal femoral hernia can sometimes arise also from reduction *en masse* (see page 191) of an ordinary femoral hernia (Tessier).

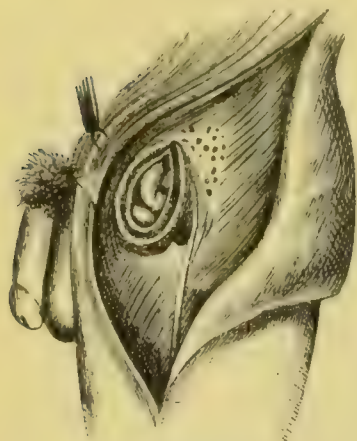


FIG. 503. — Femoral hernia (diagrammatic): The skin and superficial fascia are dissected back. The anterior wall of the hernial sac, the cellular layers, and the fascia propria herniæ femoralis have been removed.

7. The hernial sac has sometimes the form of an hour-glass—e. g., when the hernia has broken through the superficial fascia and lies under the skin, or when the protruded wall of the crural canal has been perforated.

8. Several femoral herniæ sometimes exist simultaneously, which emerge through the various points of exit for femoral herniæ that have been mentioned above. Multiple herniæ have been seen to protrude through enlarged openings in the cribriform fascia.

9. Hesselbach described a femoral hernia which protruded below the outer half of Poupart's ligament within the lacuna musculorum and descended along the anterior crural nerve.

Symptoms and Diagnosis of Femoral Hernia.—Femoral herniæ occur most frequently among women. About seventy-five per cent of all the cases are in females. They are very rare in children, whereas inguinal herniæ are by far most common in children and men. The crural canal is larger in women on account of the broader pelvis, and its resistance is lessened by frequent pregnancies. Femoral herniæ are generally of moderate size, varying usually from that of a walnut to that of a hen's egg, seldom larger. The cæcum and the appendix are by no means infrequently present in femoral herniæ; the ovary is also found occasionally and very rarely the bladder (Güterbock, Habs, Lanz, and others). Femoral herniæ are strangulated with comparative frequency. The small hernia is often overlooked, and it suddenly becomes noticeable in consequence of acute strangulation. Partial enteroceles (Littré's hernia) have, moreover, not infrequently been observed in connection with femoral herniæ (see page 186, Fig. 480). The strangulation of femoral herniæ often takes a very acute course and leads quickly to gangrene of the intestine.

The diagnosis of femoral hernia is easy when one is familiar with the above-described anatomical relations. The hernia usually lies below Poupart's ligament, while inguinal herniæ lie above it. As regards

the differential diagnosis between femoral hernia and obturator hernia the reader is referred to the latter (§ 191, page 225). Enlargements of the inguinal glands and psoas abscesses ought to be distinguished without difficulty from inflamed femoral herniæ upon careful examination. A varicose condition of the saphenous vein at the saphenous opening has repeatedly been mistaken for femoral hernia. A varix of the saphenous vein disappears at once upon pressure on the vein below the saphenous opening.

Treatment of Femoral Hernia.—Those that are capable of reduction are held back by a truss similar to the one used for inguinal hernia (Fig. 504). The pad reaches farther downward, and forms an angle with the spring.

In case of strangulated femoral hernia, taxis is more difficult because the hernia is usually small and the hernial ring is less accessible. Poupart's ligament, the fascia lata, and the crural canal should be relaxed as much as possible by flexion and adduction of the thigh.

When herniotomy is performed upon a strangulated femoral hernia, the soft parts that cover it should be divided cautiously, as they are very different in individual cases. The hernia may lie directly under the skin, when, for instance, it has broken through enlarged openings in the cribriform fascia. The cutaneous incision is usually made in the longitudinal direction of the thigh on the inner side of the femoral vein. The location of the strangulation varies according to the nature of the hernia. It may be found even at the cribriform fascia (falciform process). In the great majority of cases, however, the strangulation lies deeper in the vicinity of the septum crurale, through whose meshes the hernia passes. Dense fibrous bands are sometimes found here at the neck of the sac by which the strangulation is effected, and the division of these bands often suffices to render the reduction of the hernia possible (Nicaise). In other cases, however, Gimbernat's ligament or Poupart's ligament itself has to be incised. If the strangulation has taken place at the femoral ring, as is usually the case, the liberating incision is always made inward—that is, into Gimbernat's ligament. The incision of Gimbernat's ligament can be dangerous on one condition only—viz., when the obturator artery arises, together with the inferior epigastric, from the femoral or, more frequently, from the epigastric artery itself and runs downward in a curve over the neck of the hernial sac along and behind Gimbernat's ligament (Fig. 505,



FIG. 504.—Truss for femoral hernia.

after Roser). Under normal conditions the obturator artery arises from the internal iliac, runs forward along the outer wall of the pelvis just below the ilio-pectineal line in the loose cellular tissue between the peritonæum and the fascia of the obturator internus muscle, and passes through the obturator canal to the outer surface of the anterior pelvic wall. There exists, under normal conditions, an anastomosis between the pubic branch of the obturator artery and the epigastric artery, and if this anastomosis is abnormally large, we have

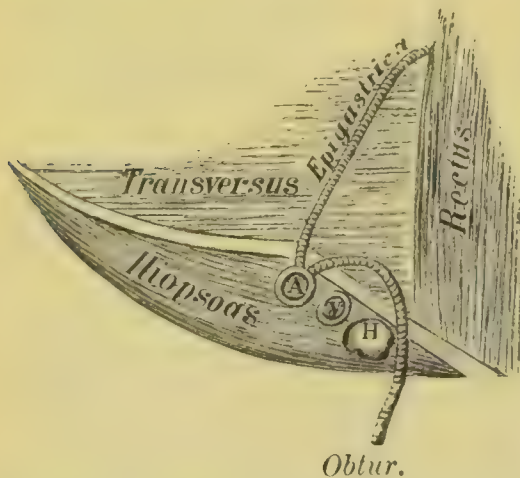


FIG. 505.—Abnormal origin and course of the obturator artery along Gimbernath's ligament (seen from inside the abdominal cavity).

the above-mentioned anomaly of the obturator artery. Thus is explained also why, in connection with the abnormal origin of the obturator from the femoral or the epigastric artery, there is still a second root of the obturator artery which arises from the internal iliac. Both roots then unite in front of the abdominal aperture of the obturator canal. The above anomaly has also been called *corona mortis* on account of the danger in case of herniotomy. It is the more dangerous as it is easily overlooked on account of its concealed position.

According to A. Cooper, who had twenty specimens showing the occurrence of this variation in the obturator artery in femoral herniæ, it occurs once in every three cases. The frequency of its occurrence in a more or less marked degree is sufficiently explained by the above-mentioned normal anastomosis between the obturator and the epigastric arteries. The abnormal obturator artery arises, according to Jatschinsky, in about 28·5 per cent of the cases from the inferior epigastric artery, in 1·2 per cent from the external iliac, and in 0·4 per cent from the femoral. The origin from the external iliac artery has no significance as regards the operation of herniotomy.

If the obturator artery in its abnormal course along Gimbernath's ligament should be wounded in performing herniotomy upon a strangulated femoral hernia, the wound should, if necessary, be enlarged, Gimbernath's ligament divided, and the artery tied in two places. In some cases the femoral or the external iliac artery may have to be exposed, so as to find the point of origin of the epigastric artery and tie this.

The division of Gimbernath's ligament should therefore always be

made, in cases of strangulated femoral hernia, more by pressure with a blunt-pointed knife and not with a cutting stroke. One is more likely to avoid injury of the artery in this way if the above variation in its course really exists. Injury of the femoral vein is also to be carefully avoided in performing herniotomy. With reference to other locations of the strangulation in femoral herniæ, the reader is referred to the varieties mentioned on page 221. It is always essential to expose thoroughly the hernia or the hernial ring without inflicting any secondary injury.

Generally speaking, radical operation upon a femoral hernia is difficult. The larger the hernia, the more likely is a recurrence to follow the operation. One must be careful to avoid injury of the femoral vein in dissecting out the hernial sac (see also § 185, page 192, *General Technique of Herniotomy*, and § 186, page 195, *Radical Operation for Hernia*). The methods of radical operation for inguinal hernia described on pages 209–219 are applicable, in suitable cases, to femoral hernia as well. The following methods of radical operation upon femoral hernia have been successfully used: 1. Ligation and removal of the hernial sac (Socin, Anderegg, Heidenthaler). 2. Closure of the hernial ring (P. Berger, Czerny, Schede). The latter is performed in different ways. The inner third of Poupart's ligament is sutured to the deep fascia of the adductors, or to the inner portion of the sheath of the femoral vessels in an oblique direction (Billroth), or Poupart's ligament is sutured to the fascia covering the adductors (Czerny, Schede), or the aponeurosis of the pectineus muscle to Poupart's ligament (P. Berger), or Gimbernat's ligament to the falciform process (Lauenstein). Macewen's method (see pages 197, 198) is also suited for femoral herniæ. Salzer, after tying off and removing the hernial sac, made a short broad flap from the pectineal fascia, and, by suturing the free edge of this flap to the inner third of Poupart's ligament, formed a firm fibrous septum crurale. This method is especially to be recommended for large femoral herniæ with a wide ring. Trendelenburg closed the crural canal by means of a pedunculated flap of periosteum and bone taken from the horizontal ramus of the os pubis or from the symphysis (see page 198).

Bassini operates as follows: The hernial sac, the fascia lata, and the pectineal fascia are exposed by means of an incision just below and parallel to Poupart's ligament. The sac and its neck are isolated with the fingers as high up as the crest of the os pubis; the sac is then opened, its contents returned into the abdominal cavity, and then twisted on itself, transfixed, and tied off. The sac is now cut away, the stump returned into the peritoneal cavity, and the crural ring closed by six or seven sutures. The first suture is passed through Poupart's ligament close to the spine of the os pubis and then through the pectineal fascia close to the horizontal ramus of the os pubis. The last three or four sutures are passed through the falciform process and the pectineal fascia, the last being inserted near the entrance of the saphenous vein. The sutures are then tied from above downward.

§ 191. **Obturator Hernia (Hernia into the Foramen Ovale).**—The obturator hernia passes through the aperture at the upper and outer

part of the circumference of the obturator foramen for the passage of the obturator artery and vein and the obturator nerve (Fig. 506). The remainder of the foramen ovale is closed by the obturator membrane. The obturator internus muscle covers the inner surface of the obturator membrane and the obturator externus the outer surface. Both are covered by fascia. According to Englisch, who has collected from literature one hundred and thirty-five cases, the hernia is either complete or incomplete. The complete obturator hernia has, according to him, a varying location—e. g., between the internal obturator membrane and the obturator internus muscle, or between the internal and the external obturator membranes. If the hernia protrudes still

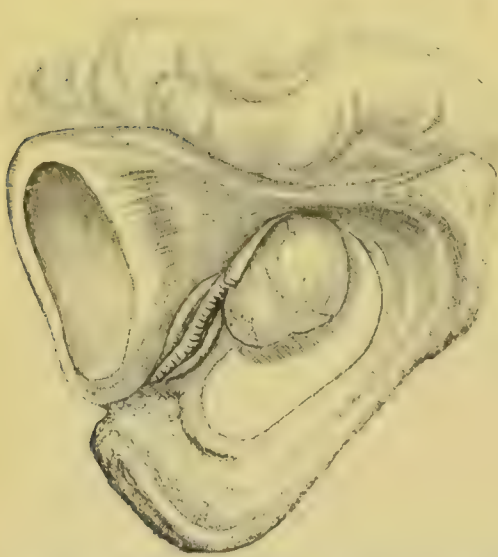


FIG. 506.—Obturator hernia: the obturator artery and nerve (the latter being partially removed in order to show the artery) are on the outer side of the hernia.

farther, it lies usually in the intermediate space, which is filled with fat, between the obturator membrane and the obturator externus muscle. From here the hernia can then pass beneath the pectineus muscle and the adductors. The hernia is always covered by the last-named muscles, and its diagnosis is for this reason much more difficult, as it can not be directly palpated. A reducible obturator hernia is seldom recognised during life. If it becomes strangulated, it can easily be mistaken for internal strangulation. A strangulated obturator hernia has also been mistaken for a strangulated femoral

hernia, and has been operated upon as such. In fact, the confusion of an obturator hernia with a femoral hernia is easily possible, as the hernial rings are separated from one another only by the narrow ramus of the os pubis. A femoral hernia and an obturator hernia have sometimes been observed simultaneously in the same individual. Many a person has died of “internal strangulation” and there has been found at the autopsy a strangulated and gangrenous obturator hernia, which had given rise to general peritonitis. For this reason, when there are symptoms of internal strangulation, one should think of the possible existence of an obturator hernia, and, with reference to this, make an examination *per rectum*, or, in case of a female, *per vaginam*, palpating with the other hand the region of the obturator foramen. Lorinser was the first to diagnose in this way a strangulated obturator hernia in a living person and to operate successfully

upon it. According to Romberg, pain radiating toward the knee along the course of the obturator nerve, in consequence of pressure upon the latter, is present in case of strangulated obturator hernia; in the majority of cases, however, this symptom has not been present. In a case reported by Krönlein, Romberg's pain was present to a marked degree. No strangulated obturator hernia was found, however, but the symptoms of intestinal obstruction were caused by acute suppurative peritonitis. In case of strangulation of an obturator hernia, gangrene of the intestine follows very quickly in consequence of the very small hernial ring, and the prognosis is therefore seldom favourable. Of eleven cases in which herniotomy was performed upon obturator herniæ, eight, according to Thiele, terminated fatally. This form of hernia is rare, being most frequent among women, in whom the obturator foramen is larger. Thiele collected from literature twenty-six cases of obturator hernia. Twenty-four of these patients were women. In one case observed by Krönlein and described in detail by Brunner, the uterus was found in the hernial sac.

Treatment of a reducible obturator hernia has, as said above, but seldom been resorted to. Hueter had a truss worn with a pad attached at a proper angle, which proved a complete success.

In performing herniotomy upon a strangulated obturator hernia, the best way is to make a longitudinal incision on the inner side of the saphenous vein or between the spine of the os pubis and the large vessels, and then to dissect down to the pectineus muscle. As mentioned above, the hernia lies either under the pectineus and the adductors or under the obturator externus. After the pectineus muscle has been exposed it is divided either transversely or longitudinally, and, if the hernia does not then appear, the obturator externus muscle should also be incised. Before dividing the constricting ring, one should determine by palpation the location of the obturator artery. The position of the artery and vein with reference to the hernial ring is, according to Trélat and Englisch, not constant, but it usually lies outside and below the neck of the sac. The obturator nerve runs, with a fair degree of constancy, higher up along the upper and outer side of the obturator foramen. The constricting ring is best divided by several blunt nicks with a knife on the inner side. Of twenty-two patients upon whom herniotomy was performed, nine, according to Englisch, recovered and thirteen died. Of fifty-six patients who were not operated upon, fifty-five died.

The radical operation for obturator-hernia follows the general rules given on pages 195-201.

§ 192. **Ischiatic Hernia.**—Ischiatic hernia is very rare, and occurs more frequently among women than men.

It is sometimes congenital, but is usually acquired, and found among women from forty to fifty years of age who have borne children. According to Garré, who tabulated eleven cases of ischiatic hernia, it may leave the pelvis in three places: 1. Above the pyri-formis muscle. 2. Below

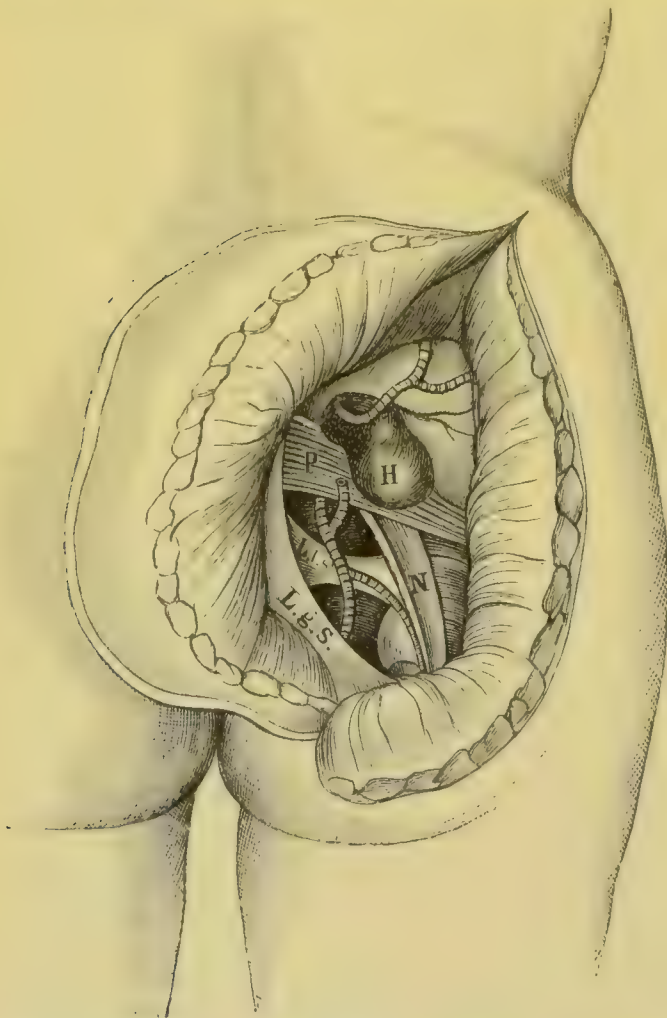


FIG. 507.—Ischiatic hernia (superior gluteal): *H*, hernia; *P*, piriformis muscle; *N*, great sciatic nerve; *L. g. s.*, great sacro-sciatic ligament; *L. l. s.*, lesser sacro-sciatic ligament; the superior gluteal artery lies above the piriformis muscle and the inferior gluteal below (Garre).

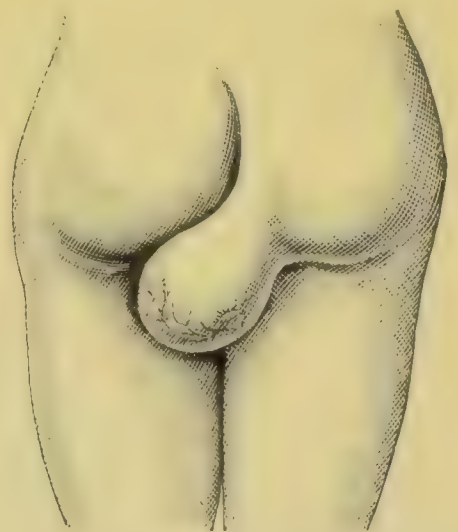


FIG. 508.—Ischiatic hernia about the size of a child's head in a woman forty years of age.

the same, and above the great sacro-sciatic ligament. 3. Through the lesser sacro-sciatic foramen. Garré proposes calling only the last-named hernia an ischiatic hernia, and designating the first two the superior gluteal and the inferior gluteal herniæ. Of these three forms, the ischiatic hernia would be the most rare and the superior gluteal hernia the most common. The superior gluteal artery lies behind the superior gluteal hernia, and, taking the same course, runs forward in a curve along the upper border of the hernia (Fig. 507). The contents of the hernia are chiefly intestine, the ovary also being sometimes found in it. According to Garré, only the right ovary has as yet been found as contents of a right superior gluteal hernia. The size of the hernial tumour is usually insignificant, so that it is not at all visible from without. In very exceptional cases large tumours have been observed,

as represented, for example, in Fig. 508, after Crosslé. Large hernial tumours in this region are usually perineal herniæ, which have often been erroneously described as ischiatic herniæ. The hernia is covered by the glutæus-maximus muscle. Spinal abscesses and aneurisms of the superior gluteal artery might have to be considered in the differential diagnosis of an ischiatic hernia. A rectal examination should never be omitted. An abdominal belt with elastic straps makes a good truss. Little is known concerning strangulation of an ischiatic hernia. In performing herniotomy for a strangulated ischiatic hernia, the best way would be, in case of a superior gluteal hernia, for instance, to work one's way in parallel to the posterior lower border of the glutæus-maximus muscle, between the tuberosity of the ischium and the coccyx, then to incise the border of the muscle named, and thus expose the hernial tumour. In enlarging the hernial ring, one would need to remember that the superior gluteal artery lies behind the superior gluteal hernia, and on its upper border. If a superior gluteal hernia should not be found, one would expose the lower border of the pyriformis muscle or the lesser sacro-sciatic foramen. A radical operation should be performed, in suitable cases, in the way described on page 195–201.

§ 193. **Perineal Hernia (Sacro-rectal or Ischio-rectal Hernia).**—Of the three designations given, ischio-rectal hernia is the best, because it indicates most precisely the place of its exit—viz., the ischio-rectal fossa, between the levator-ani muscle and the tuberosity of the ischium. The hernia passes between the fibres of the levator-ani muscle into the ischio-rectal fossa, and lies between the tuberosity and the anus (Fig. 509), or more posteriorly between the tuberosity and the coccyx. In

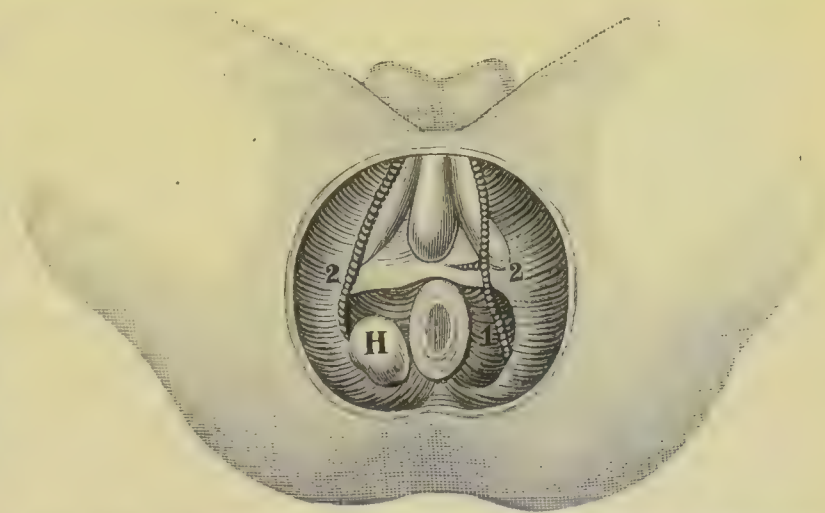


FIG. 509.—Perineal hernia: 1, levator ani; 2, internal pudic artery; H, hernia.

women the hernia may extend farther forward toward the labia and into them (so-called posterior or lower labial hernia, as opposed to the anterior upper labial hernia coming from the inguinal canal). Little or nothing is known regarding the clinical behaviour of this extremely rare hernia or regarding its strangulation. An abdominal belt with elastic straps would here also be proper as a truss. A radical opera-

tion should be undertaken, in suitable cases, in accordance with the general methods described on pages 195–201.

For rectal hernia complicating prolapse of the rectum, see § 177, pp. 159, 160.

A vaginal hernia (colpocoele) is sometimes observed in connection with prolapse of the anterior, less often of the posterior, vaginal wall. In place of the intestine, the bladder or the posterior wall of the rectum is sometimes found in the hernia (cystocele and rectocele vaginalis; see Surgery of the Female Generative Organs). The hernial tumour protruding into the vagina can usually be held back by a pessary. The prolapse of the vagina should be treated, when possible, by an operation, the technique of which we shall describe more fully in connection with the surgery of the female generative organs. In operating upon a prolapse of the vagina or the rectum, one should always think of the possible presence of such a hernia, and make a careful examination accordingly.

Ebner and Zuckerkandl have expressed the opinion that all herniæ appearing at the lower pelvic outlet are conditioned primarily upon a descent of the peritonæum between the rectum and the uterus or the bladder, in the form of a diverticulum, and that this protrusion of the peritonæum can not take place mechanically or as the result of traumatisms, but must have existed previously.

§ 194. **Internal Herniæ.**—The so-called internal herniæ include chiefly the diaphragmatic hernia and the retroperitoneal or intraperitoneal hernia.

We have already mentioned diaphragmatic hernia in vol. ii, § 124, page 691, in connection with injuries of the diaphragm, and we there stated that those arising from injuries—e. g., from ruptures or wounds of the same—have no sac, and are therefore not genuine herniæ. In fact, a large majority of so-called diaphragmatic herniæ are merely displacements of the stomach and the intestine into the pleural cavity without a hernial sac. Of two hundred and seventy-nine diaphragmatic herniæ, two hundred and forty-eight, according to Larcher, had no sac. In congenital herniæ, moreover, there is but seldom a sac. Out of eighty cases collected by Bohn, a hernial sac was proved to exist in but fourteen. In the cases of, we will say, genuine diaphragmatic hernia the hernia protrudes into the pleural cavity through the thin intermuscular clefts consisting of pleura and peritonæum, which were described in vol. ii, § 124, pages 689–691. Diaphragmatic herniæ, with or without a hernial sac, occur most frequently on the left side of the diaphragm, because their development on the right side is made difficult or prevented by the presence of the liver. Of forty-two cases, thirty-seven, according to Popp, were on the left side and only five on the right. The hernial ring has been found in various parts of the diaphragm, most commonly, however, at one of the thin intermuscular

clefts which I have described, and also at an enlarged normal opening in the diaphragm, particularly the one for the œsophagus.

The contents of diaphragmatic herniæ consist most commonly of the stomach, transverse colon, small intestine, sometimes also of the spleen, and in the rarer herniæ on the right side of the liver. The chief clinical symptom of a diaphragmatic hernia is more or less pronounced pneumothorax, varying according to the amount of intestine that has entered the pleural cavity. The varying pitch of the percussion note, depending upon the degree to which the stomach and the intestines are filled with gas, as well as upon changes of position of the organs named in the thoracic cavity, is characteristic of diaphragmatic hernia. Digestive disturbances usually exist. The share taken by the stomach and the colon in the formation of the hernia can be determined by artificially filling the stomach with water or air through the mouth and the colon through the rectum (Leichtenstern). The more abdominal viscera there are inside the pleural cavity, the more are respiration and the action of the heart impeded. Diaphragmatic herniæ are sometimes very large, however, so that they contain most of the digestive tract and spleen, and still the discomfort may be comparatively slight. Large diaphragmatic herniæ have been found at the autopsy of persons who had manifested no corresponding disturbances during life. Death not infrequently follows suddenly in consequence of strangulation and gangrene of some part of the gastro-intestinal tract. These strangulations are usually first discovered at the autopsy. If, after perforation of the intestine, a circumscribed fæcal abscess is formed, which is shut off on all sides by adhesions of the abdominal organs or the peritonæum, recovery is possible, especially after incision and drainage of the abscess. Rupture of a fæcal abscess into the pleural cavity, or gangrene of the strangulated gastric or intestinal wall, may, if the peritoneal cavity is shut off by adhesions, result merely in an empyema (thoraco-intestinal or thoraco-gastric fistula). I cured such a case by thoracotomy.

Surgical treatment of diaphragmatic herniæ comes chiefly under consideration in case of their strangulation. If symptoms of so-called internal strangulation appear, one should consider the possibility of the existence of a diaphragmatic hernia. Moreover, a careful examination should always be made to determine whether or not an external hernia exists. In doing this, one should also have in mind the very rare forms of hernia (obturator hernia, ischiatic hernia, perineal hernia, etc.). In case of internal strangulation, the attempt should be made, after the peritoneal cavity has been opened, to find the point of strangulation. Unfortunately, this is often easier said than done, and in

many cases the place in question has not been found at all (see also § 168, page 111 ff., Internal Strangulation). Naumann had a case of strangulated diaphragmatic hernia in which he was unable to replace the stomach and the intestines after laparotomy, in spite of having enlarged the hernial ring. This was due to the negative pressure in the pleural cavity. Naumann, therefore, recommends that laparotomy be supplemented by opening the pleural cavity through an intercostal space, in order to overcome the negative pressure in the pleural cavity. It is simpler, in case the diagnosis is not in doubt, to reduce the hernia from within the thoracic cavity (Postempski and others). One can then, after reposition of the abdominal viscera, close the opening in the diaphragm from within the thoracic cavity by suture, or by plastic flaps of soft parts and bone taken from the thoracic wall (Postempski, Manara, Ricolfi, De Nicola). A similar course may be pursued in

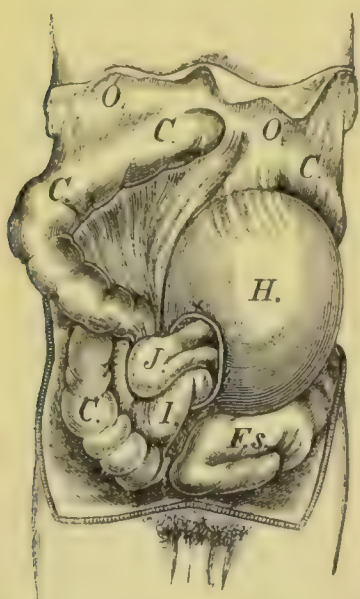


FIG. 510.—Retro-peritoneal hernia with the whole of the small intestine lying inside the hernial sac: *O*, reflected omentum; *H*., hernial sac from whose opening ++ a loop of the jejunum, *J*., and the end of the ileum, *I*., protrude; *C*., ascending and transverse colon; *F. s.*, sigmoid flexure.

case of a fresh, traumatic, diaphragmatic hernia with an open wound. The attempt has also been made in suitable cases of strangulated diaphragmatic hernia to accomplish reduction by introducing the hand into the rectum (after Nussbaum), a method which is scarcely to be recommended.

Intraperitoneal or Retroperitoneal Herniæ.

—We became familiar with intraperitoneal herniæ or internal herniæ proper in dealing with internal strangulation (§ 168, page 115), and we saw that these herniæ are really displacements of the viscera, almost always of the intestine, into normal or abnormal pouches or fossæ of the peritonæum, or through defects or tears in the peritonæum and mesentery. The lesser peritoneal cavity is one of the *culs-de-sac* which gives occasion to the development of an internal hernia (hernia into the foramen of Winslow). Internal herniæ are found most frequently in the fossa

duodeno-jejunalis, which is located at the beginning of the mesentery and the small intestine upon the bodies of the vertebræ; also in the subcæcal fossa at the inner side of the cæcum, and, finally, in the fossa intersigmoidalis at the under surface of the mesocolon and the sigmoid flexure. The hernia of the fossa duodeno-jejunalis was first described by Treitz as a retroperitoneal hernia. It may be very large and contain, for instance, the greater part of the small intestine (Fig. 510).

Treitz deserves the credit of having first shown that the sac of a retroperitoneal hernia bears a connection to the normal folds and fossæ of the peritonæum near the duodenum, the cæcum, and the sigmoid flexure. T. Jonnesco has recently written a very thorough monograph on retroperitoneal herniæ (Paris, G. Steinheil, 304 pages with 74 woodcuts, 1890), and has tabulated sixty-four duodenal herniæ, twelve pericæcal herniæ, three intersigmoidal herniæ, and eight herniæ into the foramen of Winslow.

Internal herniæ are the subject of surgical treatment only when they become strangulated. For the symptomatology and the treatment of internal strangulation the reader is referred to § 168. Laparotomy alone can come under consideration in the treatment of acute strangulation (see § 168, page 119). A case of strangulated retroperitoneal hernia which was cured by an operation was recently reported by Sonnenburg.

CHAPTER XXII.

SURGERY OF THE KIDNEY AND URETER.

Examination of the kidney.—Anomalies.—Floating kidney.—Nephrorrhaphy (nephropexy).—Extirpation of a floating kidney.—For injuries, see §§ 155, 156.—Inflammatory processes of the kidney, the suprarenal capsule, and the ureter.—Suppurative inflammation of the kidney, the pelvis, and the surroundings of the kidney (pyonephritis, pyelitis, pyelonephritis, perinephritis, ureteritis).—Tuberculosis and syphilis of the kidney.—Calculi in the kidney and in the pelvis of the kidney (nephrolithiasis).—Hydronephrosis.—Renal colic.—Nephralgia.—Tumours.—Animal parasites (echinococcus, etc.).—Aneurisms.—Pathology of the urine, with reference to surgical diseases of the urinary apparatus.—Catheterization and temporary occlusion of the ureter.—Incision of the ureter (ureterotomy).—Resection of the ureter.—Implantation of the ureter into the bladder and intestine.—Fistula of the ureter (see § 256).—Formation of an artificial fistula of the ureter in the abdominal wall.—Nephrotomy.—Nephrectomy.—Consequences of nephrectomy.—Partial nephrectomy.

§ 195. GREAT progress has been made of late years in the surgery of the kidney. To G. Simon belongs the special merit of having been the first to advance very essentially the surgical treatment of kidney diseases, and it was he who performed the first nephrectomy. Of late years renal surgery has been more and more developed by numerous German, English, and French surgeons. Of the latest works, those of Morris, Bruce Clarke, Knowsley Thornton, Brodeur, Newmann, Guyon, Le Dentu, Güterbock, and others deserve especially to be mentioned.

Examination of the Kidney.—The kidneys are situated behind the peritonæum on each side of the spinal column. The examination consists in inspection of the kidney region, percussion, and palpation in the lateral position (J. Israel), and bimanual palpation in the dorsal position. The so-called *ballottement renal* (Guyon) is also serviceable—that is, with the patient on his back, short impulses are imparted to the lumbar region by the hand underneath, whereby the kidney is lifted with a bound toward the anterior abdominal wall. If the patient is under an anæsthetic and has a thin, relaxed abdominal wall, and if the intestines are empty, a normal kidney can sometimes be felt in the lumbar region behind the free border of the ribs. The examination of the kidney by an exploratory puncture should also be mentioned, and finally exposure of the kidney from the lumbar region, and

less often by laparotomy. The intraperitoneal examination of the kidney has a certain advantage over the extraperitoneal lumbar incision only when it is essential to determine the presence of both kidneys, or when the location of the diseased kidney can not be made out with certainty. The exploratory lumbar incision should be made more frequently than has been the case hitherto, and the earlier it is done the more useful and the less dangerous it is.

Regarding the examination of the urine and catheterization of the ureters, see § 200, page 261, and § 201, page 267.

It is a fact of practical importance that a reflux of the contents of the bladder into the ureters and the pelvis of the kidney takes place not only when the bladder is injected, but also in case of artificial retention (Lewin, Goldschmidt, Guyon). This explains the occasional injurious effects of irrigation of the bladder in case of suppurative or tubercular cystitis, the development of pyelitis in the course of a cystitis, etc. Such a reflux from the bladder into the ureter is probably, however, of rare occurrence in man, owing to the fact that the ureter, which passes obliquely through the bladder wall, is compressed by the strong muscles of the bladder, which surround the orifices of the ureters like a sling (Guyon).

Anomalies.—Congenital absence of one or both kidneys has been repeatedly observed. Both kidneys are occasionally absent in extreme stillborn monstrosities. The absence of one kidney in otherwise normal infants is rare, the left being more frequently absent than the right. The other kidney is usually hypertrophied in such cases, and as a rule assumes sufficiently the function of the absent kidney. Absence of the kidney on one side occurs when the growth of the renal duct from the Wolffian duct has been in some way interfered with.

In some cases but one kidney is apparently present, because the two are joined together in the form, most frequently, of the so-called horseshoe kidney. The latter may be conditioned upon the fact that the ends of the renal ducts which are growing upward unite too early or that the upward growth of the two renal ducts is retarded. In the horseshoe kidney the two kidneys are joined together by means of connective tissue or kidney substance, usually at their lower end, sometimes also at their upper end. The two kidneys sometimes, instead of having the form of a horseshoe, coalesce in the middle or throughout their entire extent. The fused kidneys lie in the middle line in front of the spinal column, usually in the region of the promontory, less often on one side of the spine. The pelvis of the kidney is likewise single or double, according to the way in which the kidneys are joined, and there may be one, two, or even three or four ureters. The origin and the entrance of the renal vessels are likewise changed.

Congenital unilateral atrophy of a kidney is sometimes observed in consequence of defective growth of the renal duct from the Wolffian duct, or in consequence of intra-uterine inflammations. The atrophy may be so extreme that there are but slight traces of gland tissue.

The foetal fissures of the kidney are sometimes preserved—that is, the kidney remains distinctly lobulated. These fissures may pass through the entire thickness of the organ, in which case there are completely separated segments of the kidney. These strayed or completely separated portions of kidney sub-

stance not infrequently give rise to the development of tumours. The pelvis of the kidney is sometimes divided into two or more parts.

Congenital cystic degeneration of a kidney results from an impeded escape of urine—e. g., from obliteration of the ureter, the pelvis of the kidney, the papillæ or the pyramids (Virchow), and also, probably, from a primary malformation. Very large cysts (hydronephrosis) may arise, especially when the flow of urine from the pelvis of the kidney is impeded, so that they become an obstacle to delivery (see § 198, page 252, and § 199, page 256, *Hydronephrosis, Tumours, Cysts*). Congenital abnormal location of one or both kidneys sometimes occurs. This congenital “floating kidney” is found most frequently on the left side, and the involved kidney is usually displaced toward the median line or downward into the region of the sacrum, for example. The acquired floating kidney, of which we shall presently speak more fully, is much more frequent.

Of the above-mentioned malformations of the kidneys, various ones may be fatal, especially, for example, when there is only one kidney capable of performing its function and this becomes diseased. In the same way very speedy death from uræmia has sometimes been seen to follow the extirpation of a kidney, and the autopsy has then revealed absence or extreme congenital or acquired atrophy of the other kidney. Horseshoe kidneys have also been extirpated without being recognised beforehand.

The malformations of the ureter sometimes consist in the already-mentioned congenital occlusion of the same with secondary congenital hydronephrosis in consequence of accumulation of urine in the pelvis of the kidney. In other cases the ureter is abnormally small or defective, ending blindly below, for instance. Several ureters—two or three, for example—are found in cases where there are also two or three pelves of the kidney. The ureters then usually unite into a single one farther down, or they may remain entirely distinct from one another, so that each empties independently into the bladder. The orifice of the upper or the lower end of the ureter may be abnormally situated.

The anomalies in the location of the orifice of the ureter have received careful study of late by Schwarz and Wölfler. Schwarz collected sixty-eight cases from literature. In consequence of disturbances in development, a normal or supernumerary ureter may, in the male, open into or terminate blindly in any of those organs which, like the ureter, arise from the Wolffian duct—i. e., into the seminal vesicles and the vas deferens and by way of the ejaculatory duct into the urethra. In the female, Gartner's canals are the remains of the Wolffian duct, and the ureter can likewise empty into or terminate blindly in these, also into the organs that originate from Müller's duct—viz., the uterus and vagina—and, furthermore, into the urethra and vestibulum. The chief importance attaches to those cases in which the ureter ends blindly, giving rise to hydronephrosis of the kidney in question and a cystic tumour in the region of the blind end of the ureter.

Anomalies of the Suprarenal Capsules.—Defective development or complete absence of the suprarenal capsules occurs particularly in hemicephalus. According to Weigert, this defective development is due to an abnormality of the upper cervical ganglion.

Supernumerary suprarenal capsules are sometimes found in the vicinity

of the kidneys or at some distance from them—e. g., in the broad ligament. This fact is of practical importance, as such supernumerary suprarenal capsules sometimes give rise to the formation of tumours (Grawitz).

Floating Kidney.—Floating kidney is a rather frequent affection, particularly among women of the working classes. It sometimes arises suddenly in consequence of an injury, but as a rule develops gradually, in consequence of increasing relaxation of the perirenal tissues, especially of the peritonæum. In the large majority of cases the right kidney is the one affected. The displaced kidney lies most frequently in the hypogastric region. That the right kidney should be much more frequently affected is to be explained in several ways. The left kidney is, as Landau and others have stated, more firmly fixed than the right, generally speaking, especially to the pancreas, and its vessels are shorter. The ascending mesocolon is more relaxed and does not extend upward as high as the descending. The impaction of faeces which is so common in the ascending colon causes a stretching and relaxation of the peritonæum on the right side and of the ascending mesocolon; but it is chiefly the pressure of the liver upon the right kidney which explains the greater frequency of floating kidney on the right side. The left kidney does not support any large viscus. All diseases of the liver which lead to its enlargement play, in my opinion, an important part in the development of floating kidney upon the right side. If enlargement of the liver occurs, whether it be temporary or permanent, the right kidney is forced farther and farther downward, corresponding to the weight of the liver. Thus is explained the so frequent simultaneous occurrence of floating kidney upon the right side in connection with biliary obstruction and gallstones with corresponding enlargement of the liver. Floating kidney arises also from too tight lacing, because here also the right kidney is forced downward by the pressure of the liver. König observed a floating kidney as the result of the pressure of a tumour which had developed between the upper border of the kidney and the diaphragm. Of other causes all those factors are to be mentioned which lead to a stretching of the peritonæum, especially frequent pregnancy. As a result of the increasing displacement of the kidney downward, the peritonæum is invaginated and stretched and the renal vessels are lengthened. Floating kidneys are sometimes rotated in such a way that the pelvis of the kidney is directed upward. I believe, in fact, that this position of a floating kidney is the more frequent, because the hilum of the kidney is firmly held by the vessels. This rotation of the kidney may attain such a degree that disturbances of circulation ensue and the passage of the urine is interfered with by twisting of the ureter. In this case hydronephrosis results.

The disturbances attending a floating kidney are sometimes very slight, and then again so marked that every enjoyment in life is interfered with, and the patient urgently seeks relief. Patients complain particularly of constipation and digestive disturbances in consequence of the pressure of the kidney upon the ascending colon, of sharp pains in the stretched peritonæum, and of all sorts of nervous symptoms. The pain sometimes becomes very severe, and often comes in paroxysms like renal colic. The entire peritonæum is tender in such cases, the patient is strikingly weak, and there are often rigour and fever. All these symptoms have been especially observed in connection with the so-called "strangulation of a floating kidney" (Dietl). They probably attend particularly the rotation of the kidney with twisting of the ureter. If the ureter becomes permanently twisted, gradually increasing hydronephrosis ensues (see page 252). In one case of floating kidney I found several calculi which had caused very severe renal colic. Suppurative inflammations of the kidney and the pelvis of the kidney sometimes occur in consequence of microbic infection, especially in case of torsion of the ureter. The pain in floating kidney is most severe when patients walk or stand or are at work, so that in severe cases they are usually compelled to lie.

The diagnosis of a floating kidney is sometimes easy, as one can feel the characteristic form of the kidney through the abdominal wall in the hypogastric region. The kidney is usually very movable, and can easily be displaced, particularly in an upward direction. In other cases, however, the diagnosis can only be made with certainty after the overlying intestines have been emptied by cathartics, and when the patient is under the influence of an anæsthetic. When an anæsthetic is used one can often ascertain that the region of the kidney below and behind the free border of the ribs is strikingly empty. Patients with a floating kidney not infrequently go, however, from one physician to another, and the trouble is not discovered. I performed nephrorrhaphy for floating kidney in the case of a woman upon whom laparotomy had been performed by a foreign gynaecologist of reputation for a supposed ovarian cyst. The diagnosed tumour of the ovary was not found, however, nor was the floating kidney discovered.

Treatment of Floating Kidney.—The pain attending a movable kidney is sometimes so slight that special treatment is unnecessary, or, at any rate, nothing more is required than the use of a trusslike abdominal bandage for the purpose of pushing the displaced kidney upward. Schatz's bandage is strongly to be recommended—that is, a pad which is oval in the transverse direction and concave is applied above the symphysis and held in place by two springs running about the pelvis to a pad over the sacrum. The entire contents of the abdomen are supported by this bandage. In all cases in which there is great pain,

and bandages are of no avail, nephrorrhaphy (nephropexy) should be performed—that is, fixation of the kidney in its normal position by suture. I have performed nephrorrhaphy sixteen times. I performed it upon one female patient on both sides. Primary union was secured in all cases, and I therefore look upon the operation as free from danger. The results were thoroughly satisfactory. A permanent cure was obtained in ten cases, as was proved by an examination of the patients from one to three years after the operation. The condition revealed by the autopsy of a patient who died of an intercurrent disease six weeks after the performance of nephrorrhaphy is of interest. The kidney was so firmly adherent in its normal place that a recurrence would surely not have occurred in this case. From my own experience, therefore, I can recommend this operation most warmly.

The technique of nephrorrhaphy, as I am accustomed to perform it, is as follows: The operation is, of course, undertaken with the strictest observance of antiseptic precautions. The patient lies in a lateral position upon the sound side. The skin incision, from twelve to fifteen centimetres in length, runs, as for nephrectomy, along the outer border of the sacro-lumbalis muscle from the twelfth rib perpendicularly downward nearly to the crest of the ilium. After division of the skin and the latissimus dorsi muscle the anterior and then the posterior layer of the lumbar fascia are divided, and the muscle is retracted inward toward the spinal column. The lumbar artery is cut between two ligatures, and the nerve accompanying it is pushed to one side. The quadratus lumborum muscle is then divided in the longitudinal direction of the wound, likewise the transversalis fascia or the fibrous layer of the peritonæum, until the latter and the perinephric fat appear. The kidney is now pushed by an assistant from below upward into its normal place under the twelfth or under the tenth or eleventh rib, and the operator sutures it here with catgut and silk. I usually insert two sutures of silk and two of catgut, two passing through the substance of the kidney and two through the adipose capsule or through the detached fibrous capsule. One silk suture and one catgut suture take in on one side of the wound the edge of the sacro-lumbalis muscle, and are here tied. I carry the other two sutures, one of silk and one of catgut, through the fascia transversalis on the opposite side of the wound. In this way the kidney itself, as well as the enveloping capsule, is fixed on each side to the deeper layers of the edges of the wound by a catgut and a silk suture. I have never seen any harm arise from the two sutures of catgut or silk inserted through the substance of the kidney. I also insert a suture through the lower end of the kidney. Then follow suture and drainage of the wound. The first dressing is changed on

the third or fourth day, and the drainage-tube and some of the sutures are removed. The wound has usually healed eight or ten days after the operation. After this the patient should remain in bed for about four weeks longer.

Riedel detaches the fibrous capsule from the posterior border of the kidney for some distance, sutures its edges to the edges of the wound, and packs gauze between the capsule, the surface of the kidney, and the diaphragm, so as to bring about a firm adhesion of the broad granulating surfaces.

Instead of making the longitudinal incision that has just been described, the kidney may also be exposed by a transverse incision below the twelfth rib from the edge of the sacro-lumbalis muscle to the prolonged anterior axillary line.

As is evident from my own experience, and from the observations of Hahn, Langenbuch, Vanneufville, Tuffier, Frank, Keen, Angerer, and others, the fixation of the kidney by nephrorrhaphy is most likely to be permanent when the sutures are inserted through the substance of the kidney, and the patient remains in bed for from five to six weeks in all after the operation. Of fifty-nine cases in which the sutures were applied through the substance of the kidney, there were, according to Keen, thirty-nine permanent cures, and of thirty-nine cases Frank found twenty-one permanent cures. The statistics made by Sulzer and Reinboth (ninety-three nephrorrhaphies) showed a good result in 55.9 per cent, improvement in 9.7 per cent, recurrence in 15.1 per cent, no success in 16.1 per cent, and death in 3.2 per cent of the cases. In order to fix the kidney as nearly as possible in its normal place behind the tenth and the eleventh ribs, I resected the twelfth rib in one case, as De Paoli and Duvet also have done, and then sutured the kidney to the eleventh intercostal space and the periosteum of the twelfth rib.

The extirpation of a floating kidney is permissible only in exceptional cases, chiefly when the organ is otherwise diseased, or when there is great pain and nephrorrhaphy can not be performed with any hope of success. A floating kidney has frequently been removed in consequence of a wrong diagnosis, because one supposed that he had to do with a tumour or a diseased floating kidney. Extirpation has been most frequently performed on account of hydronephrosis of a floating kidney, as, for example, in the cases of Winkel, Ahlfeld, Czerny, Landau, and others. I have extirpated a floating kidney three times on account of other disease of the organ, and recovery took place in all three cases. One must always satisfy himself, before extirpation of a kidney, that the other kidney is in a sound condition (see § 203, page 270).

The extirpation of a floating kidney may be accomplished either from the lumbar region, through the usual incision for nephrectomy (see § 203, page 270), or by the intraperitoneal or transperitoneal method. In the latter case the abdominal cavity is opened, according to the location and degree of mobility of the floating kidney, either in the linea alba or at the outer border of the rectus muscle, below the umbilicus. After the abdomen has been opened, the kidney, which is usually covered by coils of intestine, is sought out and its covering of peritonæum divided with the knife or torn through bluntly with the finger or with two thumb forceps. When the kidney has been sufficiently exposed as far as the hilum, a ligature *en masse* of silk or silk-worm gut is applied about the latter, and the pedicle is severed in front of the ligature upon an aseptic gauze compress in such a way that some kidney tissue still remains. The ligature is then less likely to slip. The pedicle must not be too short. In addition to the ligature *en masse*, I then tie the separate vessels in the stump of the pedicle with catgut. One must always bear in mind the possibility of aberrant arteries at the hilum. Finally, after the ligatures have been cut off short, the pedicle is returned inside the abdomen and the abdominal wound sutured in the usual manner (see § 159, page 47, Laparotomy).

For injuries of the kidney and the ureter the reader is referred to §§ 155, 156.

§ 196. **Inflammatory Processes of the Kidney, the Suprarenal Capsule, and the Ureter.**—Among inflammatory processes, the surgeon is chiefly interested in suppurative inflammations of the kidney and the suprarenal capsule, which not infrequently become the subject of operative treatment. For the non-suppurative inflammations of the kidney the reader is referred to works on internal medicine.

Suppuration is usually occasioned by microbes that gain an entrance, in consequence of wounds, in the course of acute infectious diseases, in connection with pyæmia, septicæmia, etc. Acute suppurative nephritis usually begins by the formation of small circumscribed abscesses. Larger abscesses then result from the coalescence of the smaller pus foci, so that considerable portions of the kidney substance are destroyed. In other cases the suppuration of the substance of the kidney arises secondarily from primary suppurative inflammation of the pelvis of the kidney, induced, for example, by suppurative processes in the ureter, bladder, or their vicinity. The suppurative inflammations of the pelvis of the kidney and the kidney itself are sometimes associated with diphtheria. In severe cases of suppuration of the kidney and its pelvis the whole of the former may be destroyed, so that finally, in place of the kidney, there is a sac filled with pus (pyonephrosis).

Inflammations of the pelvis of the kidney and the ureters (pyelitis, pyelonephritis, ureteritis) arise, like inflammations of the parenchyma of the kidney, chiefly from the deposit of microbes, in the course, for example, of infectious diseases, or from the extension of diseases of the bladder, or from chemical irritation—e. g., after taking cantharides, oil of turpentine, cubebs, balsam of copaiba, etc. The latter inflammations are usually slight and of a temporary nature. Varying with the nature of the infection, a distinction may be made between catarrhal, suppurative, croupous, and diphtheritic inflammations. We are chiefly interested in those forms of inflammation which are of bacterial origin, where the microbes either reach the pelvis of the kidney and the ureter by way of the circulation, or where an inflammation of the bladder extends upward.

Pyelitis or pyelonephritis of bacterial origin is observed sometimes as an acute or chronic catarrhal inflammation of the pelvis of the kidney and sometimes as a suppurative and diphtheritic inflammation, with corresponding destruction of the tissue that is attacked, and with subsequent ulceration. The microbes spread from the pelvis of the kidney into the uriniferous tubes, causing small secondary abscesses in the medullary substance and in the cortex (suppurative pyelonephritis). The kidney may in this way suppurate more and more, and finally, in the most severe cases, be converted into a sac filled with pus (pyonephrosis). This pus sac not infrequently ruptures, giving rise to the formation of a perinephritic abscess. In most cases, however, rupture of a pyonephrosis is prevented by the capsule of the kidney, which becomes very much thickened and adherent. The collection of pus in pyonephrosis is sometimes found in a large diverticulum on the side of the kidney, which communicates with it by a small opening (II. Braun). Thiersch found peculiar spindle-shaped coagula of fibrin in a case of pyonephrosis. This was probably a case of diphtheritic infection which took place through the blood.

Pyelitis may also be due to the presence of calculi, and is then conditioned in part upon the mechanical irritation and in part upon the presence of microbes adhering to the concretions. Pyelitis due to the presence of calculi leads especially to induration and ulceration of the pelvis of the kidney, with secondary inflammation of the organ itself. The entire substance of the kidney may gradually disappear in consequence of atrophy from pressure, so that in its place there is a fibrous sac filled with stones. If the pelvis of the kidney or the ureter is occluded by a calculus, the passage of the urine may be entirely prevented, and hydronephrosis then arises with secondary atrophy of the tissue of the kidney (see § 198, page 253). This form of pyelitis also may result in

the formation of a large pus sac, with complete destruction of the tissue of the kidney. A hydronephrosis or pyonephrosis may reach such a size as to be mistaken for a large ovarian cyst. It is of importance, however, for the differential diagnosis of these tumours that they proceed from the region of the kidney or the hypochondrium, and are usually covered by intestine.

Inflammations of the pelvis of the kidney and the ureter also arise in consequence of animal parasites, especially the echinococcus and *Distoma hematobium*, whose eggs are deposited in the urinary passages and develop into embryos. Of other animal parasites, the *Eustrongylus gigas* is found in very rare cases in the pelvis of the kidney. The female is a blood-red worm about a metre in length, while the male is only from about thirty two to forty centimetres long (see also pages 260 and 266, Animal Parasites in the Kidney).

Perinephritic Abscess.—Perinephritic abscesses frequently result from suppurative pyelitis when the free escape of pus is prevented by obstruction of the ureter, and the wall of the pelvis of the kidney or the ureter is more and more thinned by ulceration. These abscesses, however, also occur without continuous extension of the suppuration or without rupture of a pyonephrosis into the surrounding tissue, simply in consequence of the migration of microbes into the neighbouring tissue. In still other cases the perinephritic abscess develops primarily in the surroundings of the kidney or in the suprarenal capsule. A pyonephrosis or perinephritic abscess sometimes ruptures into the intestine, the pleural cavity, the lung, and rarely into the peritoneal cavity. The pus often burrows toward the crest of the ilium, and the skin is here perforated, or the pus may take a more direct route and break through the skin in the region of the lower ribs. Rupture into the general peritoneal cavity, with diffuse suppurative peritonitis, is the least frequent.

The course of perinephritic abscesses is sometimes very chronic and at other times more acute. I have seen several cases with a very acute course in which a fluctuating swelling developed in a few days in the region of the kidney, below the free border of the ribs and to the outer side of the sacro-lumbalis muscle. No symptoms whatever indicative of disease of the kidney had preceded, so that I am inclined to consider perinephritic abscesses that take such an acute course as *primary* phlegmonous inflammations of the tissue about the kidney. In other cases the course of these abscesses is very slow, local symptoms being absent, it may be, for a long time. Fever is always present. Only after some weeks do the local symptoms become more and more prominent, especially pain, œdema, and swelling in the region of the kidney and below

the free border of the ribs. In all perinephritic abscesses arising secondarily from the kidney, the symptoms of an affection of the kidney have of course appeared in advance and have usually existed for a long time.

The symptomatology of suppurative inflammations of the kidney and the pelvis of the kidney consists chiefly in changes in the urine, particularly in an admixture of blood and pus. In acute pyelitis the characteristic epithelia of the pelvis of the kidney are found in the urine. If the flow of urine from the diseased kidney is prevented, by the incarceration of a stone in the ureter, for instance, the urine is normal in case the other kidney is sound. In all chronic inflammations of the kidney the urine contains albumin and, possibly, casts (see § 200, page 265, Examination of the Urine).

More or less fever attends all suppurative inflammations of the kidney, the suprarenal capsule and the surroundings of the kidney, particularly all acute suppurations. In chronic suppurations, periods free from fever and febrile attacks often alternate.

Local symptoms are also very important, of course, for the diagnosis, especially pain in the region of the kidney, whether spontaneous or caused by pressure, œdema of the overlying skin, swelling and fluctuation, etc. In case of large tumours in the lumbar region, the attempt should be made by careful palpation and percussion to determine their extent and the probable place of their origin. All tumours which originate in the kidney are usually covered by intestine. Exceptions occur, however—as, for example, when a tumour of the kidney has broken through the peritonæum and, in the course of its further growth, has pushed the intestines to one side. The tumour can usually be marked off by a tympanitic zone from the small pelvis. Finally, the result of an exploratory puncture is important for the diagnosis.

Every nephritic and perinephritic abscess is, from a prognostic standpoint, to be regarded as a serious affection. Still, modern antiseptic surgery has improved the prognosis here also, as in every suppuration which is accessible to the knife.

The treatment of acute and chronic non-suppurative inflammation of the kidneys pertains to the province of internal medicine, and we can only occupy ourselves here with the surgical treatment of suppurative inflammations.

Large abscesses in the region of the kidney are opened by an incision along the outer border of the sacro-lumbalis muscle, corresponding to the area of fluctuation if the latter exists. The incision should extend perpendicularly downward from the twelfth rib as in performing nephrectomy. An exploratory puncture should first be made.

The abscess is then opened by puncture with a pointed bistoury and the incision is enlarged either with a blunt-pointed knife or with dressing forceps. A drainage-tube is inserted, and healing generally follows quickly in perinephritic abscesses, where the kidney itself has not participated in the development of the abscess. If the latter is the case, and the kidney is found in a condition of suppuration, nephrotomy should be added. Czerny, however, is right in his statement that such pyonephroses are often not cured by nephrotomy alone and that nephrectomy must often be performed later when the patient is stronger. In fact, the statistics of Herczel and J. Schmidt relating to the cases in which nephrectomy was performed by Czerny and Bardenheuer for suppuration of the kidney (tuberculosis, abscess, pyonephrosis) show that the prognosis is very favourable. Bardenheuer cured seventeen out of nineteen cases, and Czerny nine out of eleven cases. One should therefore, when possible, in abscess of the kidney perform nephrectomy at once, in case the other kidney is sound, as Schede also recommends. The extirpation of such suppurating kidneys is very difficult on account of the extensive and firm adhesions. If the sac is too firmly adherent to the surroundings, one must content himself, it may be, with incision and drainage of the cavity. In connection with all abscesses of the kidney and the pelvis of the kidney one should be on the lookout for renal calculi. In a case of this kind I found several calculi in the kidney, but they lay so hidden in the pus sac and were so completely surrounded by thick, indurated tissue that they were overlooked until the autopsy of the patient, who died of uræmia in consequence of parenchymatous degeneration of the other kidney. Such suppurating kidneys containing calculi should be removed. Large pus sacs (pyonephroses) should be exposed by an incision along the outer border of the sacro-lumbalis muscle, the pus evacuated by puncture with a trocar, the opening enlarged with the knife, and finally the sac packed with iodoform gauze or a drainage-tube inserted. The walls of the pus sac are attached to the edges of the wound by a few sutures. If the extirpation of such pyonephroses is practicable, nephrectomy is to be performed here also, either immediately or later, when the patient's condition has improved. (See also § 202, page 269, Technique of Nephrotomy.)

Tuberculosis of the Kidney is usually metastatic, less often secondary to tubercular disease of the ureter, bladder, prostate, testicles, or seminal vesicles, etc. Primary renal tuberculosis is rare.

Renal tuberculosis takes the form sometimes of a miliary tubercular eruption in connection with acute miliary tuberculosis, and sometimes of a chronic caseous process, which likewise begins with the formation of miliary

nodules and then later produces larger or smaller caseous foci with increasing destruction of the tissue of the kidney. The latter may finally be more or less completely destroyed, so that in place of the involved kidney there is only a thick-walled sac. The pelvis of the kidney is, as a rule, diseased, and here also there are found in the thickened mucous membrane either miliary tubercles or caseous infiltrations and ulcers. The pelvis is usually distended in consequence of the accumulation of urine, and is often more or less filled with caseous masses. If the ureter is likewise involved, it is noticeably thickened, is permeated by tubercles, and in its mucous membrane ulcers and sometimes large necrotic areas are found. The tubercular process in the kidney not infrequently breaks through into the surroundings, giving rise to the formation of a perinephritic tubercular abscess.

The course of tuberculosis of the kidney is always very chronic if we leave out of consideration those cases of miliary tuberculosis which are observed in the course of acute general miliary tuberculosis. Severe colicky pains are often present in tuberculosis of the kidneys, especially when the pelvis and the ureter are diseased, and the escape of the urine is prevented by caseous masses in the pelvis and in the ureter. In the later stages the enlarged tubercular kidney can often be distinctly felt under the free border of the ribs.

As regards the diagnosis, the presence of tubercular disease in other parts of the genito-urinary tract or in the lungs is of great importance. The surest proof of its existence is the detection of tubercle bacilli in the urine.

Renal tuberculosis is, generally speaking, little adapted for surgical treatment, because the kidney is usually not the only organ that is diseased. Should this be the case, the extirpation of the diseased kidney would then be indicated on condition that the other kidney were sound. Madelung tabulated sixty cases of renal tuberculosis, but in very few of them was a permanent cure effected by nephrectomy. Nephrotomy secures at the best only palliative benefit. As for the rest, one must confine himself to a symptomatic treatment, and above all mitigate the sufferings of the patient. Perinephritic tubercular abscesses are incised, scraped, and packed with iodoform gauze.

Syphilis of the Kidney.—The kidneys are seldom affected in syphilis. Gummata are sometimes found in the kidney, or we may have to do with a syphilitic interstitial nephritis resulting in the formation of cicatricial fibrous tissue, induration, and contraction of the organ. Amyloid degeneration of the kidney is observed especially in connection with syphilitic marasmus in the later stages of syphilis. P. Tommasoli claims that syphilis of the kidneys is more frequent. He found changes in the kidneys during all the stages of syphilis, which sometimes presented all the symptoms of nephritis and sometimes manifested themselves only in albuminuria. Two main groups of renal syphilis may be distinguished—the more acute forms in the first stages of the disease, and then the more chronic interstitial inflammations in the later stages. The treatment, in addition to the adoption of dietetic and hygienic measures, is of a general antisymphilitic character.

§ 197. **Renal Calculi (Nephrolithiasis).**—We have already learned something of the formation of calculi in the kidney (nephrolithiasis)

(page 242) as a cause of pyonephrosis and perinephritic abscess, but we must here take up this affection somewhat more in detail.

Deposits of uric acid and urates are frequently found at the autopsy of infants but a few days old. The urates that are deposited are usually sodium urate and ammonium urate. These so-called uric-acid infarcts form white or yellowish-red streaks, especially in the pyramids of the kidney. They are of especial importance from a medico-legal point of view, as they indicate, as a rule, that the child has lived, has breathed after birth (Virchow). This is not a perfectly sure proof, however, as, in exceptional cases, uric-acid infarcts have also been found in the kidneys of stillborn fœtuses (Schulze, Ebstein).

Deposits of urates in the kidney also occur with striking frequency in children during their first ten or fifteen years, and finally in later life, in connection with the uric-acid diathesis, with gout, which is attended with the formation of too much uric acid. The deposits of uric acid and urates, so-called *renal sand*, consist partly of fine crystalline needles of uric acid of a whetstone shape (see Fig. 512, A, page 263), partly of amorphous precipitates of urates, especially of sodium urate, less often of spherical or rosette shaped crystals of ammonium urate (Fig. 512, B, page 263). The *renal sand* lies partly in the uriniferous tubes, which may be completely obstructed thereby, and partly in the connective tissue. This deposition of uric acid and urates takes place when, in consequence of a predisposition or the mode of life—e. g., too abundant use of meat and too little exercise, or in consequence of disturbances of circulation associated with diseases of the heart, etc., an excessive amount of uric acid and urates is formed, so that the urine can not hold it all in solution. According to Voit and Franz Hofmann, the formation of gravel is especially favoured by acid fermentation of the urine, as the uric-acid alkali is then decomposed by the acid sodium phosphate contained in the urine, with the formation of a basic phosphate. Large renal calculi are sometimes formed from renal sand or gravel, especially in the pelvis of the kidney, which may be completely filled with them. Such stones of the pelvis of the kidney not infrequently reproduce the form of the latter and the calyces more or less completely (Fig. 511).

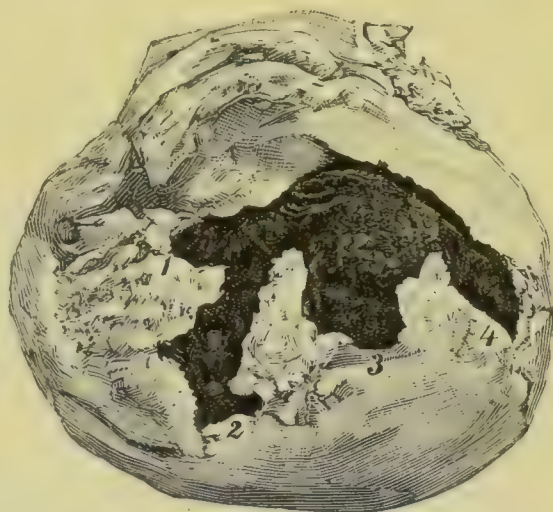


FIG. 511.—Large stone in the pelvis of the kidney with four processes (1, 2, 3, 4) running into the kidney substance.

The number and the size of the renal calculi are very variable. The size may be anywhere from that of a pea, a hazelnut, or a walnut to that of a hen's egg. Blood clots, casts, the eggs of *distoma hæmatobium* (Griesinger), etc., are often found as a nucleus of the stones.

In addition to these most frequent uric-acid concretions there are other deposits in the kidney, partly in the form of gravel and partly as larger concretions. These other renal calculi remain small, however, as a rule. Thus concretions of carbonate, phosphate, and oxalate of lime, ammonio-magnesium phosphate, cystin, xanthin, and indigo occur. The roundish, soft, yellow cystin stones are rare, and the brown xanthin stones still more so. (For a more detailed description of the different urinary calculi see § 212.) Ebstein and Nicolaier produced urinary calculi in dogs and rabbits by feeding them with pure oxamide, an ammoniacal derivative of oxalic acid. The largest were found in the pelvis of the kidney and the smallest in the form of gravel, in all parts of the urinary apparatus. The concretions consisted of oxamide with an albuminous framework.

The changes in the kidney in consequence of the presence of calculi are sometimes so great that the normal tissue of the kidney disappears more and more from atrophy produced by continuous pressure of the calculi in proportion as they increase in number and size. In other cases suppurative inflammations of the kidney and the pelvis of the kidney result—viz., suppurative nephritis, pyelitis, pyelonephritis, and pyonephrosis, with rupture, not infrequently, into the surroundings of the kidney, so that perinephritic abscesses arise, as was described more fully in § 196, page 243. The inflammation frequently extends to the ureters and the bladder. The gravel and smaller stones are discharged with the urine through the ureter into the bladder and then out through the urethra; or the stones may remain in the bladder and here enlarge, especially when the urine is in a state of fermentation, or when the mucous membrane of the bladder is inflamed. Renal calculi not infrequently become incarcerated in the ureter or remain embedded in the pelvis of the kidney and prevent the escape of the urine. The longer this obstruction to the flow of the urine continues, the more completely is the parenchyma of the kidney destroyed by the continuous pressure, and the more likely is hydronephrosis to ensue, which may lead to the formation of a sac as large as a man's head (see Hydronephrosis, § 198, page 252). Collections of pus in the pelvis of the kidney or in the kidney (pyonephrosis) may also attain a marked size, as we mentioned in § 196. If the obstacle to the escape of the urine or the pus—i. e., the incarcerated stone, is in the ureter, the latter may rupture.

Nephrolithiasis and its consequences are usually observed in but one kidney, so that the function of the diseased organ is assumed by the other sound kidney without harm to the patient. Sometimes, however, both kidneys are affected, the second being also the seat of stone formation, or of secondary parenchymatous degeneration, or of secondary inflammation propagated from the bladder along the ureter.

The symptoms of nephrolithiasis are at first very slight. The urine usually contains gravel at times, and other symptoms may be completely absent in the milder cases. In case of abundant deposit of gravel, and in case of ordinary renal calculi, the following symptoms are of especial diagnostic importance: Paroxysms of pain, so-called renal colic, are usually present—that is, pain in the region of the kidney radiating along the course of the ureter. The intensity and the number of these attacks of pain vary a great deal. The pain is conditioned mainly upon the incarceration of a stone—e. g., in the ureter—upon the dilatation of the urinary passage above the stone by the accumulated secretion or urine, and upon the occasional contraction of the dilated ureter in its attempt to remove the obstruction. The secretion of urine is generally diminished during such paroxysms of pain. When they are severe, only a few drops of very concentrated urine with a large amount of sediment are evacuated. The urine frequently contains blood, mucus, or pus. If the other kidney is sound, normal urine is discharged during the attacks of pain, in case the flow of urine from the diseased kidney is wholly suspended by the incarceration of a stone in the ureter. It also occurs, however, that the sound kidney likewise suspends its action in consequence of a reflex vascular spasm caused by incarceration of the stone, and the patient dies of anuria (Nepveu, Claude Bernard, Cohnheim, Roy, Eckhardt, Grützner, J. Israel). We have here to do, perhaps, with causes similar to those of the anuria in the first hours after the performance of nephrectomy. Under ordinary conditions the urine is either normal during the time that it is free from the attacks, or has a more or less decided sediment and contains gravel. An admixture of blood, mucus, or pus always indicates already existing inflammatory processes in the bladder, in the ureter, or in the pelvis of the kidney and the kidney itself. If both kidneys are diseased, anuria may result from the incarceration of renal calculi in the ureters, and death from uræmia may ensue within a few days, with coma and convulsions. It not infrequently happens that when one kidney contains a calculus the other kidney is the seat of parenchymatous degeneration or of inflammation secondary to suppurative cystitis. Such cases have a very unfavourable prognosis. Renal calculi break through externally in rare cases, and are found within an

abscess in the lumbar region (Werner, Th. Annendale, Lafitte, Schützenkrantz, Banlim).

The diagnosis of renal calculus is, in the majority of cases, not difficult. It is a matter of great importance from a prognostic and therapeutic standpoint whether or not one kidney is sound. The sound condition of one kidney is assured if, during an attack of renal colic, the urine which has hitherto been mixed with blood, mucus, pus, or gravel, is perfectly normal. This urine comes from the sound kidney, while the secretion from the diseased kidney is temporarily suspended in consequence of the incarceration of a stone in the ureter.

One can also determine by catheterization of the ureters whether a kidney is performing its function normally or not. (For the technique of catheterization of the ureters the reader is referred to § 201.) Rectal examination with the entire hand, after Nussbaum and Simon, may be of great diagnostic value in connection with nephrolithiasis of a horseshoe kidney (see § 170, page 134).

Treatment of Nephrolithiasis.—As a precautionary measure against the formation of gravel in persons predisposed to this affection, a suitable mode of living is, above all, to be recommended. Such persons should take food that is easily digestible and should adopt a diet with not too much meat, but more vegetable food. Treatment for a time at Carlsbad, Wildungen, Vichy, Tarasp, etc., stands deservedly in good repute. It is a good plan for patients whose urine contains gravel to drink as much fluid as possible—e. g., selzer water with light Moselle wine, and also to exercise a good deal. Lithia water is particularly to be recommended as a drink—e. g., as salicylate, benzoate, or carbonate of lithia, or the Salvator spring which is rich in lithia. Ebstein recommended piperazin as a good remedy for dissolving uric acid.

During an attack of renal colic morphine should be administered hypodermically and the patient placed in a lukewarm bath. If the pain is very severe and hypodermic injections of morphine are not effective, the inhalation of chloroform is to be recommended. Pirogoff spoke highly of rectal etherization.

If there are genuine calculi in the kidney and the latter is already extensively diseased, and if hydronephrosis or pyonephrosis is present, operative treatment is indicated. The incision of the diseased kidney (nephrotomy) is undertaken in such cases, and the stones are removed by means of suitable forceps, a sharp spoon, a lithotomy scoop, or a periosteal elevator (nephrolithotomy). The stones often lie deeply embedded and very much hidden, and a long probe, silver catheter, or the like may be necessary to find them. For the technique of nephrotomy the reader is referred to § 202, page 269. Nephrotomy has often been undertaken on account of renal colic (nephralgia), but the sus-

pected calculus has not been found. Nevertheless, the pain often disappears after the operation. Tiffany collected from the literature of the subject twenty-one such cases (see also below).

Stones in the pelvis of the kidney should be removed by opening the same (pyelotomy), and subsequently suturing the wound, which can then heal by primary union (Czerny). If a fistula of the pelvis of the kidney does not close, nephrectomy is indicated.

The extirpation of a kidney containing calculi is especially indicated, aside from the case just mentioned of fistula of the pelvis of the kidney after pyelotomy, when several stones are present, although the organ itself is more or less sound. The diseased kidney is to be removed in such cases in order permanently to relieve the suffering of the patient. Nephrotomy would not be sufficient here, since a recurrence would be more or less certain, because there would still be too much kidney tissue capable of performing its function. If, on the contrary, the substance of the kidney has been destroyed in consequence of the calculi or of the hydronephrosis or pyonephrosis, incision, or nephrotomy, is often sufficient, especially in those cases where nephrectomy would be difficult and dangerous, on account of the extensive adhesions. One must satisfy himself in each case, before performing nephrectomy, that the other kidney is present and in a sound condition. It may happen that, after exposing the organ, no stone can be felt externally. In such cases a long aseptic needle should be inserted into the kidney in different directions so as to make sure of the diagnosis before extirpating the organ.

For the incision of the ureter, ureterotomy, in connection with the incarceration of a stone in the same, see page 269.

Boseman and others have called attention to the so-called tenesmus of the kidney, a symptom which is observed especially in connection with chronic inflammation of the mucous membrane of the vesical portion of the ureters, and which often closely resembles the renal colic due to the presence of a stone. This tenesmus is, however, not so painful as renal colic. It occurs much more frequently—several times a day—and may be produced by the slightest causes. Boseman performed colpo-cystotomy in two cases and colpo-uretero-cystotomy in eleven cases, always with vaginal drainage.

As was mentioned above, nephrectomy has in some cases been performed on account of severe renal colic, and upon a thorough pathological examination the involved kidney has been found perfectly sound, so that one may properly, as I think, designate such cases as neuralgia of the kidney (nephralgia). Légeu, distinguishes a purely idiopathic form of nephralgia—e. g., in hysteria, malaria, or after injuries—and a symptomatic or reflex form produced by diseases of more or less remote organs—e. g., the nervous system, the bladder, the prostate, the intestines, the other kidney, etc. The attacks of pain usually come on very suddenly, and the region of the

involved kidney is extremely painful. By way of treatment an exploratory lumbar incision is to be recommended, and in the severest cases nephrectomy.

§ 198. **Hydronephrosis.**—By hydronephrosis is understood an increasing dilatation of the pelvis of the kidney in consequence of accumulation of urine. The causes of the latter are both congenital and acquired.

Congenital hydronephrosis is due most commonly to congenital stenosis or occlusion of the ureter and the urethra; also to valve formations along the course of the urinary passages, extreme phimosis, etc.

The causes of acquired hydronephrosis are very numerous. It arises most frequently from the incarceration of a stone in the pelvis of the kidney or in the ureter; also from stricture, cicatricial contraction, or compression of the ureter by a tumour, especially one of the ovary, the uterus, and the bladder, or in the course of pregnancy; and also from traumatism with injury of the kidney (traumatic hydronephrosis). In traumatic hydronephrosis due to injury of the kidney the pelvis becomes filled with urine and blood (hydro-hæmatonephrosis). Injury to the kidney or the ureter may also give rise to extravasation of urine in the neighbourhood of the kidney which may resemble an ordinary hydronephrosis (so-called pseudo-hydronephrosis).

The obstruction is sometimes conditioned upon a valve mechanism due to an oblique attachment of the ureter to the kidney (Virchow, Hausemann); in other cases this valve formation is brought about by rotation of the kidney forward. Not infrequently hydronephrosis is caused by obstacles to the discharge of urine from the bladder, such as hypertrophy of the prostate, stricture of the urethra, phimosis, etc.

In consequence of these congenital and acquired obstacles to the passage of the urine, the parts of the urinary apparatus located above the obstacle, especially the pelvis of the kidney and the ureter, become more and more distended from the accumulation of urine. In this way very large tumours may arise. The ureter may be dilated, for instance, to the size of the small intestine, and its walls are usually very much thickened. Reichel observed in one case of hydronephrosis a hernialike prolapse of the greatly dilated ureter through the inguinal canal, without other hernial contents. Cysts as large as a man's head frequently arise from very gradual dilatation of the pelvis and the calyces of the kidney, with compression of the parenchyma of the same. Enormous tumours are sometimes seen. Birch-Hirschfeld saw hydronephrosis of a horseshoe kidney in a boy seventeen years of age which filled the whole abdominal cavity and was twice as large as a man's head. The walls of such large hydronephrotic sacs are usually

very much thickened by layers of fibrous tissue. The tumour sometimes decreases and then increases in size (so-called intermittent hydronephrosis), and, in fact, it may completely disappear, only to return again after a time. Hydronephroses are more frequently open sacs, from which a portion of the contents constantly flows off into the bladder (H. Braun). Intermittent hydronephrosis is much more frequent than was formerly supposed, as appears also from the new and thorough article of F. Terrier and M. Baudouin. In intermittent hydronephrosis the ureter at times becomes obstructed and then again patent, causing a corresponding gradual or sudden evacuation of the sac into the bladder. The occasional obstruction to the escape of urine is conditioned upon various causes (concretions, blood clots, plugs of pus, displacement of the kidney or the ureter with kinking or twisting of the latter, compression of the ureter by tumours of the neighbouring organs, etc.). Hydronephrosis also occurs rather frequently in the case of a floating kidney, and is then due to kinking and torsion of the ureter. Among sixty-six cases of acquired hydronephrosis, floating kidney existed in twenty-eight, according to F. Terrier and M. Baudouin, the patients being nearly all women, and the affection being in nearly every case on the right side, just as in the ordinary floating kidney (see page 237). This hydronephrosis of a floating kidney is often of the intermittent variety.

Pressure of the fluid in the pelvis of the kidney brings the tissue of the kidney more and more to atrophy, so that it may finally disappear completely. The distended calyces are usually still visible, however, as projecting septa in the sac of the cyst. The fluid in a hydronephrosis consists at first of urine and mucus. The secretion of urine from the involved kidney then becomes less and less, however, as the pressure of the accumulated fluid increases, so that finally there is a colloid fluid of a mucilaginous and serous character, containing cholesterolin, in which the constituents of urine are no longer demonstrable. The fluid often has a brownish colour, caused by blood from ruptured vessels. Even after the secretion of urine has ceased, the contents of the hydronephrosis constantly increase through the secretions of the mucous membrane of the pelvis and the calyces of the kidney. The increase in size is very gradual and goes on uninterruptedly. The cysts may reach such dimensions as to cause death from compression of the respiratory and digestive organs with increasing marasmus. A rupture of the hydronephrosis sometimes occurs with discharge of the fluid into the peritoneal cavity, followed by secondary peritonitis in case the fluid contains microbes. A temporary improvement may follow rupture of the cyst into the peritoneal cavity, in case the contents are free from

microbes the fluid being absorbed by the peritonæum. The sac, however, gradually fills again after the opening made by the rupture has closed. Spontaneous evacuation and cure of the hydronephrosis may follow when the obstacle to the discharge of the urine—e. g., the stone incarcerated in the ureter—passes on into the bladder. The increase of the tumour in size is usually unattended by fever or inflammatory symptoms. A pyonephrosis may result from every hydronephrosis—e. g., from the entrance of pus cocci when a non-aseptic puncture is made. Acute sepsis may follow in such cases from sloughing of the sac.

Hydronephrosis is almost always unilateral, and the other kidney, which is usually hypertrophic by way of compensation, assumes the function of the diseased organ. There are usually, therefore, no changes in the urine either in quality or quantity. Parenchymatous degeneration of the other kidney not infrequently develops, however, and death from uræmia then results.

Diagnosis and Prognosis of Hydronephrosis.—The location of the tumour is especially important for the diagnosis of hydronephrosis. It is usually covered by intestine. The colon lies in front at first, but is pushed later toward the median line. The tumour does not usually extend beyond the median line. The lung and the diaphragm are generally pressed upward by a large hydronephrosis and the fundus of the stomach and the transverse colon may be displaced downward to such an extent or stand in so vertical a position that the pylorus lies at the umbilicus. The hydronephrosis sometimes breaks through the peritonæum and continues its growth within the peritoneal cavity, pushing the intestines aside. It is always characteristic of hydronephrosis that the tumour occupies the kidney region from which it extends a variable distance downward and that it is usually covered by the colon. The presence of the colon over the tumour can be demonstrated by inflating the former with carbonic-acid gas (Ziemssen), with hydrogen, or with air. Ziemssen's method is the best—i. e., he introduces into the intestine by means of a rectal tube and an irrigator at intervals of several minutes a solution of fifteen parts tartaric acid and twenty parts bicarbonate of soda, in three or four portions, and allows about a hundred grammes of water to flow in each time. Tumours of the ovary and the uterus enlarge from below upward, push the intestines to one side, and are not covered by them. They can usually be recognised by a bimanual examination through the vagina and rectum (see Surgery of the Female Generative Organs). In doubtful cases a careful examination should be made with the patient under an anæsthetic after thorough evacuation of the bowels by the use of castor oil and enemata. Of other tumours of the kidney the echinococcus is most easily mistaken for hydronephrosis. I have repeatedly seen such soft, fluctuating sarcomata of the kidney that I fully believed that I had to do with a hydronephrosis. In all such cases one should determine the diagnosis by means of an exploratory puncture or a lumbar incision. Extraperitoneal laparotomy is also of value for the diagnosis of these cases (see § 159, page 48). The diagnosis of hydronephrosis of a floating kidney may be difficult in some cases.

We have already sufficiently indicated the prognosis of hydronephrosis. If the obstacle to the escape of the urine is not removed, an unlimited increase in the hydronephrosis takes place, and if a means for its evacuation is not provided, death may finally result from interference with the action of the heart and the lungs as well as with the digestion. Death not infrequently follows also from the change of a hydronephrosis into a pyonephrosis, from rupture of the sac, from parenchymatous disease of the other kidney, etc.

Treatment of Hydronephrosis.—The treatment of hydronephrosis by aspiration has usually only a temporary effect. The best way is to expose the tumour by a longitudinal incision along the outer border of the sacro-lumbalis muscle, as in nephrectomy (see § 203, pages 270–272), or by means of a transverse incision below the twelfth rib (see pages 272, 273), open the sac extraperitoneally after an exploratory puncture, evacuate the contents, and strive to bring about contraction and atrophy of the sac by means of gauze drainage. In case of a very large hydronephrosis it is often well to make the longitudinal lumbar incision a little farther forward and to divide the cutaneous coverings in the axillary line from above and behind in a downward and forward direction. The posterior and anterior lumbar incisions are always sufficient, judging from my own experience, and in simple incision of the sac it is neither necessary nor advisable to expose the tumour by an incision through the anterior abdominal wall. In case the anterior lumbar incision is made, the peritonæum may be detached and pushed aside, or it may be divided and the sac opened at two sittings. In the latter case the abdominal wound is packed from three to five days with iodoform gauze. It is unnecessary to suture the wall of the cyst into the abdominal wound. After the sac has united on all sides with the edges of the abdominal wound, it is opened. If the tumour is large, a counter-opening should also be made farther back in the lumbar region and drainage inserted here. After evacuation and drainage of the sac an antiseptic dressing is applied, and the after-treatment should be in strict conformance to antiseptic rules. Nephrotomy, after Küster, is also a good method (see § 202, page 269). A renal fistula with more or less discharge is most likely to persist when the tissue of the kidney has not been brought entirely to atrophy by the hydronephrosis.

Extirpation of the sac is much more difficult and dangerous than its incision, but healing takes place much more quickly than in simple incision, after which chronic invalidism is sometimes observed for a number of years. If the other kidney is in a sound condition, if the sac is not too firmly adherent to the surroundings, and if but little of the tissue of the diseased kidney remains which is capable of performing its function, extraperitoneal extirpation of the sac from the

lumbar region may be attempted. In very large tumours an intraperitoneal extirpation has been undertaken through the anterior abdominal wall. In this way two layers of peritonæum are divided—first the parietal peritonæum of the abdominal wall, and then that lying in front of the sac. Hydronephrosis has frequently been operated upon in this way in consequence of a wrong diagnosis, the case being thought to be one of ovarian cyst or of a solid tumour of the kidney. In case of complication of hydronephrosis with a malignant new growth or tuberculosis, nephrectomy is always indicated (see also §§ 202 and 203, page 270 ff., *Technique of Nephrotomy and Nephrectomy*).

§ 199. **Tumours of the Kidney and the Suprarenal Capsule.**—Among primary tumours of the kidney, small multiple fibromata from the size of the head of a pin to that of a pea are not infrequent. Larger fibrous tumours are rare, as are lipomata, myxomata, and angeiomata. Lipomata and myxo-lipomata in the region of the kidney arise chiefly from proliferation of the adipose capsule of the kidney. The small heteroplastic, lipomalike tumours which occur in the substance of the kidney, or are subcapsular, are formed, according to Grawitz, from the proliferation of strayed germs of the suprarenal capsules containing more or less fat. They resemble in a greater or less degree the so-called strumæ of the suprarenal capsules, and Grawitz therefore designates them as *Strumæ lipomatodes aberratæ renis*. In rare cases the tissue of the kidney is permeated by many lipoma nodules, from the size of a millet grain, for instance, to that of a walnut (Alsberg).

Sarcomata of the kidney are observed most frequently during the first months and years of life. They are usually congenital tumours, or at least develop during the first months of extra-uterine life. They also arise from detached tissue of the suprarenal capsules (malignant struma of the kidney—Grawitz). These malignant strumæ of the kidney occasionally lead to metastatic sarcomata of the bones (Helferich). Most sarcomata of the kidney are very malignant, rapidly growing, soft, round-celled, and spindle-celled tumours. They are not infrequently so soft that they seem to fluctuate, and may be mistaken at first glance for hydronephrosis. Sarcomata of the kidney sometimes contain non-striated muscular fibres (rhabdomyoma sarcomatosum), which originate, according to Eberth and others, from the non-striated muscular fibres found on the surface of the kidney. The presence of striated muscular fibres has also been demonstrated (Cohnheim, Marchand), the result, probably, of abnormal foetal inclusion of muscular tissue in the kidney. Hildebrand has described an endothelioma which develops from the adventitia of the blood-vessels and the endothelium of the lymphatics, and contains a striking amount of glycogen.

All the tumours thus far mentioned—that is, fibromata, myxomata, lipomata, and sarcomata—usually originate in the perirenal tissue. This category also includes the embryonic adenoma of the kidney occurring in childhood, especially the adeno-myosarcoma, and others which may develop from the Wolffian body.

Adenoma of the kidney is not infrequently observed, and it usually occurs as a solitary nodule in the cortex, varying in size up to that of a walnut. It arises mainly from proliferation of the glomeruli, or of the uriniferous tubes as well. Adenomata also develop, according to Grawitz, from the proliferation of strayed tissue of the suprarenal capsules. Weichselbaum and Greenish distinguish the alveolar adenoma, resulting from proliferation of the straight uriniferous tubes, and the papillary adenoma, resulting from proliferation of the epithelium lining the collecting tubes of the cortex. Birch-Hirschfeld was unable to verify the latter. A carcinoma may finally develop from any adenoma by atypical growth of the epithelium.

Primary carcinoma of the kidney usually involves one kidney, but may attack both, and forms sometimes hard and sometimes very soft growths. It occurs most commonly after chronic inflammations, particularly of the pelvis of the kidney, and after stone formation. There are at first circumscribed nodules, and later an entire kidney may be destroyed by the growth. Especially the soft varieties of cancer form large tumours. The course is usually very slow. Metastases are not common, occurring most frequently in the lungs, when the carcinoma breaks into the renal veins or into the vena cava. The neighbouring lymph glands are affected comparatively late. It follows, from the rare occurrence of metastases and the late involvement of the neighbouring lymph glands, that the conditions are favourable for the extirpation of a carcinoma of the kidney, and in fact a permanent cure is possible as the result of early operation. As yet a permanent cure has been secured by nephrectomy only in exceptional cases, because the operation has been performed too late. Of twenty-eight cases of extirpation of the kidney for carcinoma, but three, according to Guillet and J. Israel, resulted in a permanent cure.

The metastatic tumours of the kidney are chiefly sarcoma and carcinoma.

Carcinoma develops in the ureter as a secondary growth from the bladder or the uterus, or, less frequently, from the rectum. Small cysts in the wall of the ureter are usually without clinical importance.

Of cysts of the kidney I mention in the first place the very rare dermoid. Madelung described a sebaceous cyst of the kidney. Most of the cysts are retention cysts, resulting from an accumulation of

secretion after obstruction, compression, or occlusion of the uriniferous tubes and the mouths of the Malpighian tufts; also after inflammation of the pelvis and the calyces of the kidney (Thorn). The small cysts attending contraction of the kidney in consequence of chronic interstitial nephritis or arterio-sclerosis, which usually vary in size from that of a pea to that of a walnut, are examples of retention cysts. They are sometimes observed also in otherwise normal kidneys. The number and size of the cysts are very variable. They are sometimes so numerous that but little of the normal substance of the kidney remains. The contents of the cyst are either a clear fluid or the latter is yellowish brown, hæmorrhagic, or colloid. Constituents of urine are always demonstrable in the contents.

The extensive cystic degeneration, which is observed in the so-called foetal cystic kidney and also in later life, is of great practical importance. The foetal cystic kidney is more frequently bilateral than unilateral. It sometimes forms such marked tumours that they are an obstacle to delivery. We have really to do in the foetal cystic kidney with the development of urinary cysts from dilatation of the uriniferous tubes and the Malpighian tufts, in consequence of some obstruction to the evacuation of the urine—e. g., as Virchow proved, from obliteration of the papillæ in consequence of foetal inflammation. Thorn and Durlach found the cause to be an inflammation of the pelvis and the calyces of the kidney, with extension of the same to the papillæ, attended by compression and atrophy of the uriniferous tubes. Such foetal cystic degenerations of the kidney may also arise from obstruction of the uriniferous tubes by urates. In case of obstacles to the escape of the urine from the pelvis of the kidney and the ureter, hydronephrosis is more likely to develop with dilatation of the pelvis of the kidney and atrophy of its parenchyma caused by continuous pressure.

Cystic degenerations of the kidney analogous to those observed among infants occur in adults also, and the causes of their development are essentially the same. The clinical symptoms of these cystic degenerations of the kidney among adults are, as a rule, strikingly slight. Death sometimes occurs, however, from acute uræmia resulting from a sudden insufficiency of the impaired kidney.

The suprarenal capsules are of special importance in connection with the formation of tumours in the region of the kidney. They are concerned particularly in the development of carcinomata and large sarcomata as well as melano-sarcomata. Mixed tumours also of the most varied kind originate in the suprarenal capsules, including those which contain ganglion cells and nerve fibres (Weichselbaum, Dagonet).

Echinococcus cysts are the most common of the cysts of the suprarenal capsule. Virchow described nodules consisting of kidney tissue rich in fat (*struma lipomatosa suprarenalis*; see also page 256). There is found, as is well known, in Addison's disease a caseo-fibrous degeneration of the suprarenal capsules, but the causal connection is unknown.

Treatment of Tumours of the Kidney.—Carcinomata and sarcomata are best suited for extirpation. In all malignant tumours I lay great stress upon the thorough removal of the adipose capsule which so frequently contains tumour germs. Extraperitoneal nephrectomy is the best method of extirpating tumours of the kidney, and very large neoplasms can be removed in this way. It is only in exceptional cases that intraperitoneal or transperitoneal nephrectomy is justifiable. Péan recommends for such cases a transverse incision at the level of the umbilicus from the outer border of the rectus to the outer border of the sacro-lumbalis. Cysts of the kidney may be treated simply by nephrotomy as we described it on pages 255, 256, for hydronephrosis. In case of malignant tumours, operation should not be delayed too long. For the purpose of making sure of the diagnosis, an exploratory lumbar incision is very much to be recommended at an early period. Hæmaturia, pain in the region of the involved kidney, loss of flesh and strength, and the existence of a tumour, are the most important indications of a malignant neoplasm of the kidney. The number of favourable terminations of nephrectomy for malignant renal tumours is still small. A. Siegrist collected sixty-four cases of malignant tumour, twenty-nine carcinomata, and thirty-four sarcomata, the nature of the tumour not being given in one case. Nephrectomy was performed sixty-one times. Thirty-two patients died from the effects of the operation, nine from recurrence and metastasis, and eleven of those operated upon were still well after a period varying from five months to two years. Out of ten cases of malignant tumour of the kidney operated upon by Israel, five were without recurrence from one to seven years after the operation, and a sixth died, without recurrence, one year later, of perforative appendicitis. (For the technique of nephrectomy see § 203, page 270 ff.)

Animal Parasites.—Of animal parasites in the kidney, the echinococcus occurs most frequently, but it is rarer here than in the liver and the lungs. Among 367 cases of echinococcus disease, Davaine found the kidney affected thirty-one times. Neisser found it affected only eighty times among 983 cases, and Madelung only seven times among 196 cases. Echinococcus of the kidney may also form very large fluctuating cystic tumours. A spontaneous cure is possible, espe-

cially from rupture of the sac into the pelvis of the kidney and evacuation of the contents, with subsequent shrinkage and calcification of the sac. Echinococcus of the kidney sometimes ruptures into the peritoneal cavity, into the intestine, into the pleural cavity, and the lung. In fact, perforation into neighbouring organs is strikingly frequent. Berand found that perforation occurred forty-eight times in sixty-four cases. Its prognosis varies greatly according to the organ that is involved. Rupture into the intestine is the most favourable. Of four cases, three recovered and one died (Berand). Regarding the diagnosis of echinococcus, which is determined chiefly by an exploratory puncture and an examination of the fluid obtained, the reader is referred to what was said on the subject of echinococcus of the liver (see § 161, page 55). At the outset the diagnosis is difficult or impossible. The condition of things is first made clear by rupture of the cyst into the pelvis of the kidney and evacuation of the cyst contents through the urethra.

The treatment of echinococcus of the kidney by incision and drainage conforms essentially to the rules given for hydronephrosis on pages 255, 256. The extraperitoneal lumbar incision along the outer border of the sacro-lumbalis muscle is to be chosen if possible. Should the intraperitoneal incision be necessary, it should be performed in two stages, as for echinococcus of the liver (see page 56, Echinococcus of the Liver). Resection of the diseased portion of the organ may be undertaken in suitable cases. Nephrectomy is rarely indicated.

Cysticercus cellulosæ and *Pentastomum denticulatum* are very rare and without practical importance.

Filariæ (*filaria sanguinis*) are found in large quantities in the renal vessels and the kidney tissue of persons whose blood contains them. The *filaria sanguinis* is found, as is well known, only among people living in the tropics. It probably gets into the blood from the intestine. Its presence in man was, moreover, first demonstrated in the urine. Hæmaturia is the chief symptom in connection with the accumulation of filariæ in the blood-vessels of the urinary apparatus. Chyluria and chylous diarrhoea are present if the filariæ obstruct the thoracic duct, giving rise to lymph engorgement of the intestines and the urinary apparatus.

The eggs of *Distoma hæmatobium*, which develop into embryos and likewise occasion hæmaturia, are sometimes found in the kidney (especially in the pelvis), the ureter, and the bladder, likewise only in the tropics (Bilharz, Griesinger, Kartulis). They were first discovered by Bilharz in the corpse of an Egyptian, and their presence was often demonstrated by Griesinger at autopsies in Egypt. The parasite induces acute inflammation with ulceration of the mucous membrane, especially in the pelvis of the kidney, the ureter, and the bladder, and there then result later thickening of the tissue and incrustations of the eggs with urates and lime salts.

The *Eustrongylus gigas* is still to be mentioned, a blood-red parasite which is found more frequently in the pelvis of the kidney of the marten, the dog, the wolf, and the seal, but is rarely observed in man. The female is sometimes a metre in length, the male only thirty-five to forty centimetres.

In cases where there is a communication between a loop of intestine and the pelvis of the kidney or the ureter, nematoids have been found in the same.

Aneurisms of the renal artery from traumatism or arterio-sclerosis are rare. Oestreich, Armstrong, Gruber, Hochenegg, and Hahn have published observations of this condition. Hahn distinguishes three varieties depending on the location—viz., in the trunk, in a terminal branch, or at the point of bifurcation of the artery with involvement of the kidney substance. Pulsation is not present. Auscultation is of importance. The treatment consists in extirpation of the aneurism with the involved kidney. Without operation the termination is fatal.

§ 200. **General Remarks upon the Physiology and Pathology of the Urine with Reference to Surgical Diseases.**—The daily quantity of urine passed by a healthy individual varies considerably. It is especially influenced by the amount of fluid consumed and given off. In warm weather—in consequence of the increased secretion of sweat—less urine is passed than in winter. The average amount of urine secreted in twenty-four hours by a strong, healthy man amounts to from fifteen hundred to two thousand cubic centimetres. A reduction in the amount of urine (oliguria) is observed especially in fevers, acute and chronic diseases of the kidneys, disturbances in the circulatory organs, etc. An increase in the amount of urine (polyuria) occurs particularly during convalescence from febrile diseases, in connection with diabetes mellitus and insipidus, with certain diseases of the kidneys, etc. Complete absence of urine (anuria) is due chiefly to occlusion of the urinary passages, especially the urethra in the region of the prostate or the neck of the bladder, in the course of uræmia, temporarily in connection with great loss of water from the system, etc.

The specific gravity of the urine is likewise variable. The greater the amount of urine secreted, the lower usually is the specific gravity, and, *vice versa*, the less the amount of urine, the higher the specific gravity. Assuming that the average amount of urine for twenty-four hours amounts to from fifteen hundred to two thousand cubic centimetres, the specific gravity of normal urine is from 1015 to 1020. The changes in the specific gravity of the urine under pathological conditions is of great importance from a clinical standpoint. The specific gravity measures, as it were, the degree of the metabolism or the amount of solid constituents secreted in the urine. A sudden lessening of the concentration of the urine in nephritis, for example, when the quantity of urine remains the same, is of great importance. It shows that the diseased kidneys are incapable of secreting the urea and the salts formed in the organism. The specific gravity of the urine is determined by the use of the urinometer. The surest determination is obtained by use of the pycnometer. The urinometer of O. Zoth is also very serviceable for the quantitative determination of albumin, urea, and sugar.

The reaction of normal urine is mildly acid, and this acid reaction is conditioned not upon free acid, but upon acid salts—viz., acid phosphates and

urates. Healthy individuals may, however, pass alkaline urine, especially in the morning hours (Quincke). In anæmia also the urine often has an alkaline reaction. The alkaline reaction of the urine in consequence of ammoniacal fermentation of the urea from the presence of microbes is of especial importance for the surgeon—e. g., in connection with suppurative processes in the kidney and suppurative cystitis. In this fermentation of the urine the urea is decomposed and forms carbonic acid and ammonia. Alkaline fermentation occurs in normal urine after it has stood for some time, but usually not before the expiration of twenty-four hours.

The colour of the urine depends, generally speaking, upon the degree of its concentration. The more concentrated it is the darker it is, and the more diluted the paler it is. Its colour is conditioned upon various pigments, viz., indican, urobilin, uroerythrin, urochrome, and uroglauclin. The colour of the urine undergoes manifold changes under pathological conditions. In fever a high-coloured, dark-yellow to brownish-red urine is usually passed; likewise in diseases of the heart. Abnormally pale urine is often observed during convalescence after a severe illness, and also in connection with polyuria, anæmia, etc. In other cases the abnormal colour of the urine is conditioned upon an admixture of blood or hæmoglobin, of bile pigment, etc. The urine becomes a deep yellow, yellowish-green, or blackish-green from the presence of bile pigment in diseases of the biliary passages. The colour is also changed by the internal or external use of certain drugs. Carbolic acid in the urine gives it a dirty grayish-green colour, especially after it has stood for some time. This peculiarity is probably conditioned, according to Baumann and Preusse, upon the formation of oxidation products of the hydroquinone. Finally, a bluish-red and brownish-red colouring of the urine arises from taking rheum and senna.

Freshly passed urine has, in consequence of the presence of aromatic acids, a peculiarly aromatic and not disagreeable odour. This odour gradually disappears after the urine has stood for a time; the latter is decomposed, becomes alkaline, and then has an ammoniacal odour.

The normal constituents of the urine are more largely organic than inorganic. The inorganic constituents are sodium, potassium, calcium, magnesium, ammonium, iron, and traces of silicic acid. The first named are present as salts, being in combination with sulphuric, hydrochloric, and phosphoric acid. The organic constituents of the urine are urea, uric acid, hippuric acid, oxalic acid, oxaluric acid, creatine, creatinine, xanthin, hypoxanthin, aromatic ethylsulphuric acid, sulphocyanic acid, succinic acid, pigments, and extractives. The quantitative amounts of these organic and inorganic substances are, of course, subject to constant change, and are conditioned essentially upon the kind of food ingested. If, for example, meat is consumed in abundance there is a larger secretion of urea. These matters can not, of course, be taken up here in detail.

In normal recently passed urine there are no structural elements, aside from a few epithelial cells from the urethra. If urine is evacuated after an emission of semen, it contains, as a rule, a large number of spermatozoa. Numerous epithelial cells from the vulva are usually present in the urine of females.

Several salts are precipitated in urine that has stood for some time, and

the greatest variety of vegetable organisms are found in it. The salts usually precipitated after a short time, in consequence of cooling, consist chiefly of amorphous urates and yellowish rhombic crystals of uric acid and oxalate of lime, and, as the alkaline fermentation increases, there are found, besides the microbes, which cause the alkaline fermentation or the

decomposition of the urea, crystals of ammonia, magnesium phosphate, and ammonium urate.

The sediment of acid urine consists most frequently of amorphous urates of potassium and sodium, of uric-acid crystals (Fig. 512, A), oxalate of lime (Fig. 513, A), cystin (Fig.

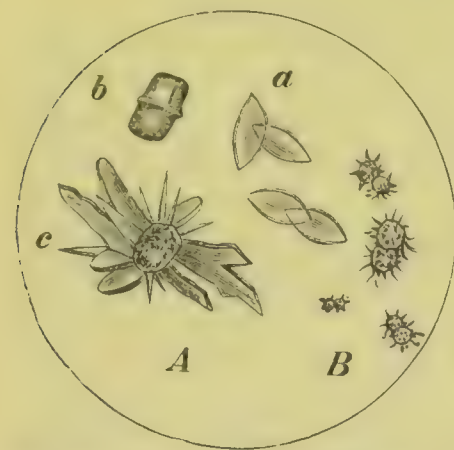


FIG. 512.—A, uric-acid crystals; *a*, whetstone shaped; *b*, barrel shaped; *c*, group of crystals; B, ammonium urate.

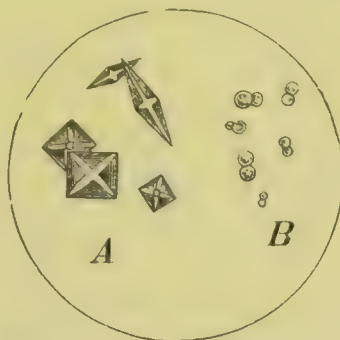


FIG. 513.—A, crystals of calcium oxalate; B, of calcium carbonate.

514, *a*), and tyrosin (Fig. 514, *b*). The sediment of alkaline urine consists especially of amorphous phosphate and carbonate of lime (Fig. 513, B), of crystals of ammonium urate (Fig. 512, B), ammonio-magnesium phosphate (Fig. 515), phosphate of lime, and phosphate of magnesia. The chief of the solid constituents of the urine, urea (it constitutes about one half of them), is never found in the sediment, as it is so freely soluble. In cachexia—e. g., in consequence of malignant tumours—the amount of urea in the urine decreases by degrees, and finally remains constant below twelve grammes in twenty-four hours (Rommelaere, Ranzier, Thiriar). Tests for urea are of great importance as regards the indication for and

prognosis of surgical operations.

The crystals of uric acid assume very varied forms. The fundamental form, however, approaches the rhombic. Whetstone-shaped crystals are found most frequently (Fig. 512, *a*), then those that are barrel-shaped, or the crystals may lie in a compacted form (Fig. 512, *c*). Sodium and potassium urates in acid urine form a rose-coloured or brick-dust-coloured sediment. The ammonium urate, always in alkaline urine, forms rosette-shaped crystals (Fig. 512, B). The crystals of oxalate of lime are shaped like letter envelopes (Fig. 513, A), and those of ammonio-magnesium

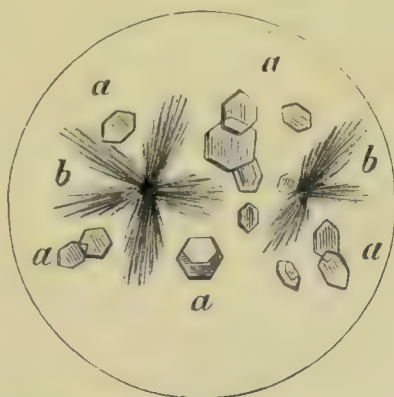


FIG. 514.—*a*, crystals of cystin, and *b*, tyrosin.

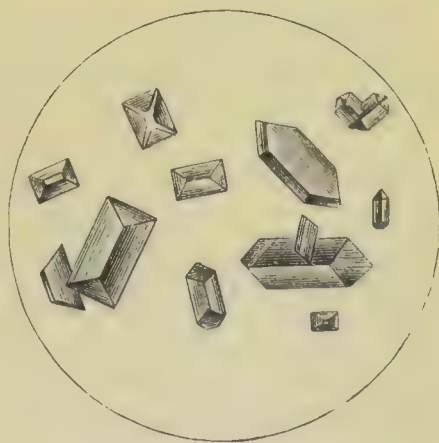


FIG. 515.—Crystals of ammonio-magnesium phosphate.

phosphate. The crystals of ammonio-magnesium phosphate are shaped like letter envelopes (Fig. 513, A), and those of ammonio-magnesium

phosphate resemble a coffin lid (Fig. 515). Cystin crystals form, as a rule, hexagonal tablets (Fig. 514, *a*). They occur rarely in the sediment, and are usually associated with cystin calculi (see urinary calculi). Tyrosin and leucin are found in the urine in acute yellow atrophy of the liver and acute phosphorus poisoning. They always indicate marked decomposition of the protein substances of the body, and they then represent more or less the urea, the normal product of such decomposition. Tyrosin crystallizes in needles, which lie together in tuftlike or sheaflike forms (Fig. 514, *b*), while leucin forms dark spheres of varying size. Xanthin occurs still more rarely in the urine (see urinary calculi).

Under pathological conditions the urine frequently contains epithelial cells which may come from the kidney, the pelvis of the kidney, the ureter, the bladder, the urethra, or in females from the vulva. The differentiation of these epithelial cells is of considerable diagnostic importance.

Renal epithelia (Fig. 516, II, *f* and *g*) in the urine always indicate that the kidney is diseased. They are desquamated in large quantities in parenchymatous nephritis. If the urine contains a large number of renal epithe-

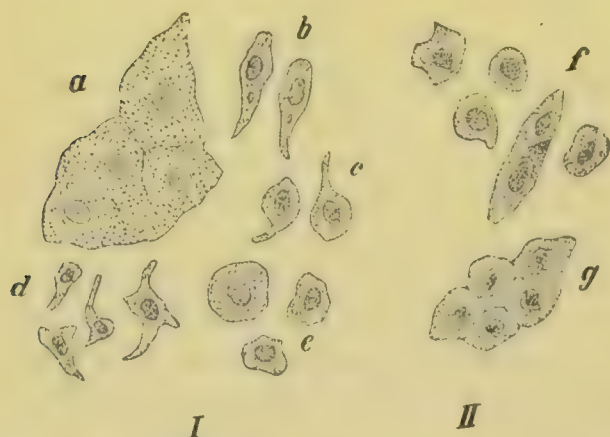


FIG. 516.—Epithelial cells found in the urine: I, bladder epithelium; *a*, superficial layer; *b*, *c*, *d*, and *e*, cells from the middle and deeper layers. II, *f* and *g*, renal epithelium.

lia which have undergone fatty degeneration, the diagnosis of chronic nephritis can be made with certainty. Renal epithelia have, generally speaking, the form represented in Fig. 516, II, *f* and *g*. They are sometimes pale and homogeneous and sometimes granular, and have often undergone fatty degeneration. They are occasionally much larger, depending upon the part of the uriniferous tube which they line. They are most easily recognised when they occur in groups or in the form of casts, the so-called epithelial casts (see Fig. 517, *c*). In case of amyloid degeneration

of the kidney, the epithelia show on the addition of iodine, when seen under the microscope, the iodine-starch reaction. A solution of aniline-iodine-violet (1 to 100) stains them a bright red.

The epithelia of the pelvis of the kidney, the ureter, and the bladder have in general the same type. The epithelial lining consists of three layers of cells, which are differently formed according to their location (Fig. 516, I, *a*, *b*, *c*, *d*, *e*). The most superficial layer usually consists of large, flat, polygonal cells lying close to one another (Fig. 516, I, *a*). The cells of the middle layer are distinguished by one or, less often, two processes (Fig. 516, I, *b*, *c*, *d*), and the cells of the deepest layer are generally round or oval and smaller than the superficial cells (Fig. 516, I, *e*). The epithelial cells of the male urethra are cylindrical and rather long, contain small granules, and have an oval nucleus, usually with one, less often two, bright drops upon it, which resist the action of acetic acid (Bizzozero).

Squamous epithelia from the vulva and the vagina are found in special

abundance in the urine of females in case of catarrhal inflammation of the vulva and vagina. They present, as a rule, large, irregular polygonal cells with clear protoplasm. In addition to this form of cells there occur also younger epithelial cells which are usually much smaller and circular in form.

Red blood-corpuscles are very frequently found in the urine in connection with diseases or injuries of the urinary passages and the kidneys, and also white blood-corpuscles (mucus-corpuscles or pus-corpuscles). The more severe the inflammation the greater the number of white blood-corpuscles in the urine.

The occurrence of casts in the urine is also of the greatest importance. The following distinct forms are distinguished (Fig. 517): In the first place

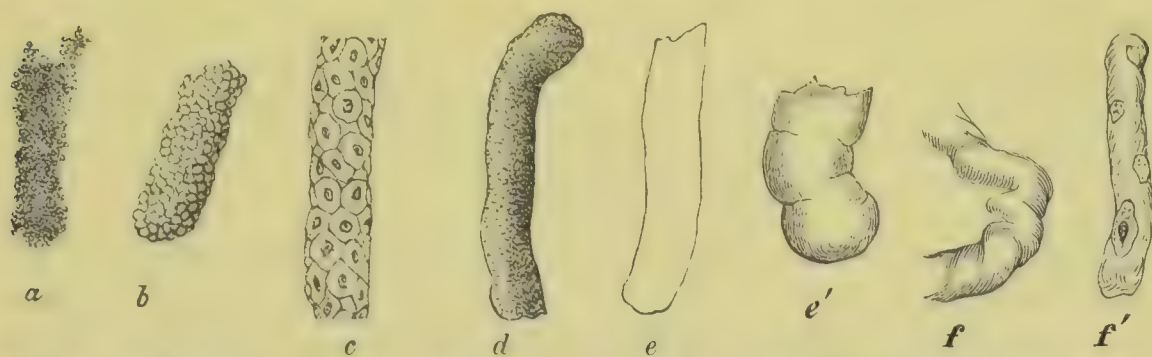


FIG. 517.—The different varieties of casts: *a*, cast made up of urates found in infants; *b*, cast composed of red blood-cells; *c*, epithelial cast from the kidney; *d*, granular cast; *e e'*, waxy casts; *f*, hyaline cast; *f'*, hyaline cast covered with leucocytes, and an epithelial cell from the kidney.

the urates may collect into brownish-red casts (Fig. 517, *a*). They consist of brownish-red granules and crystals of uric acid or oxalate of lime. They occur especially in the urine of infants during the first days after birth, and originate in the uric-acid infarcts of the kidney.

Casts also arise from a conglomeration of red blood-corpuscles or from blood clots when they retain the form of the uriniferous tubes in which they have lain (Fig. 517, *b*). If renal epithelia are desquamated in groups, retaining the form of a certain part of a uriniferous tube, the above-mentioned epithelial casts are found (Fig. 517, *c*).

Hyaline, waxy, and granular casts are also of great diagnostic importance. Hyaline casts (Fig. 517, *f f'*) are pale, transparent cylinders of very varying length and diameter. They are straight or convoluted, and often contracted or expanded at different parts. They are sometimes covered here and there with white blood-corpuscles, renal epithelia, and globules of fat, various crystals, etc. A modification of these hyaline casts are the waxy casts (Fig. 517, *e e'*), which are distinguished by a slightly yellowish colour, a waxlike lustre, and a stronger power of refraction.

Finally, the granular (fibrinous) casts are still to be mentioned (Fig. 517, *d*), which arise chiefly from decomposition of the blood casts and epithelial casts. Transition forms are also found not infrequently between the hyaline and the granular casts. Clusters of cocci—e. g., in pyelonephritis—may easily be mistaken for granular casts.

The presence of casts always indicates a more or less marked inflamed

condition of the kidneys. In acute and chronic nephritis and in amyloid degeneration casts are always present in the urine, and all forms may exist simultaneously. If epithelial casts only are found in the urine, we have to do, as a rule, with a desquamative nephritis, which usually has a favourable prognosis. The presence of hyaline and granular casts in the urine indicates a decided pathological change in the parenchyma of the kidney, which usually leads to chronic degeneration and has a more unfavourable prognosis. In the second stage of chronic nephritis numerous renal epithelia are found which have undergone fatty degeneration and which are sometimes free and sometimes present in the form of casts. In the later stages of chronic nephritis, with fibrous or granular degeneration of the kidney, which may speedily prove fatal, strikingly narrow casts are found and free or inclosed shrunken epithelia. The presence of epithelia that have undergone amyloid degeneration is a sure indication of amyloid degeneration of the kidney. These assume a red colour upon the addition of methyl aniline (one-per-cent solution of aniline iodine-violet), while non-amyloid cells are coloured blue. Besides these epithelia that have undergone amyloid degeneration, there are others that have undergone fatty degeneration and the same casts as in acute and chronic nephritis.

In order to render casts more distinct, a drop of a solution of iodine and iodide of potassium or of a solution of fuchsin is added. The best way is to let the urine stand for a number of hours (ten to fifteen), then to pour off the fluid and collect the sediment upon a filter, wash it off with distilled water, and then examine it under the microscope, coloured or uncoloured.

Of other microscopic constituents found in the urine, the following may also be briefly mentioned: Pus cells are often found in very large numbers in inflammatory processes of the urinary organs, tubercle bacilli and caseous masses in tuberculosis, tumour cells in neoplasms, and, furthermore, various micro-organisms, pigment, crystals of the most varied kind, etc. We have described the most important of the latter on pages 263, 264. In rare cases sarcinæ have been found in the urine. They are without special importance, however, and do not pass up from the bladder to the kidney (A. Hartge). Sarcinæ are found only in acid urine, and disappear with an increase of the microbes of decomposition.

Of animal parasites which occur in the urine I mention especially hooklets and membrane shreds of echinococcus, the *Filaria sanguinis hominis*—e. g., in galacturia and hamaturia (Lewis)—also *Distoma hæmatobium* and *capense*, *Cercomonas urinarius*, and *Eustrongylus gigas* (see pages 260, 261). Schreiber found a parasite in the urine of a Hungarian woman which he calls *Rhabditis genitalis*. This parasite probably inhabits the external female genital organs and makes its way from here into the urinary passages.

The urine sometimes contains gas ("pneumaturia")—e. g., in diabetes, in case of a communication between the bladder and intestine, etc. In pneumaturia the urine contains the *Bacterium lactis aërogenes*, *Bacterium coli communis*, and yeast fungi, whose power to form gases is well known.

We must content ourselves with these very general statements regarding the examination of the urine. We have not room to take up in detail all the questions pertaining to the subject, and the reader must therefore be referred for information regarding the chemical examination of the normal and

pathological urine to a treatise upon clinical diagnosis—e. g., that of Bizzozero, Frühauf, Jacksch, Vierordt, and others.

§ 201. **Catheterization of the Ureters and other Operations upon them.**

—Catheterization of the ureters, first accomplished by G. Simon, is most easily performed upon females. After dilatation of the female urethra (see Surgery of the Female Genito-urinary Organs) the forefinger is introduced into the bladder, the orifice of the ureter found, and the catheter passed along the forefinger into the same. Pawlik devised the instrument represented in Fig. 518.

He catheterizes the female ureter as follows:



FIG. 518.—Pawlik's ureteral catheter.

The patient assumes the knee-elbow position, and the posterior vaginal wall is held backward and downward by means of a Simon or a Sims speculum. The trigonum vesicæ is more or less distinctly marked upon the anterior vaginal wall by transverse furrows which are crossed by two diverging longitudinal furrows in the vicinity of the portio vaginalis. The catheter represented in Fig. 518 is then introduced into the bladder in such a way that the bent end is directed downward. It is then pushed forward within the bladder in an oblique direction corresponding to one or the other of the longitudinal furrows, and its end is controlled from within the vagina. The orifice of the ureter is usually found only after a long search. That the catheter has entered the ureter is shown by the feeling, by the instrument being caught, and by the escape of urine in drops from its handle end. This escape of urine does not occur at once, however, but only after a time. A metallic catheter can be passed up as far as the pelvic inlet, where the ureter changes its course. A small elastic catheter could be pushed still farther into the ureter through a metallic catheter which is open at the end. Emmet, for the purpose of catheterization of the ureter, exposed the trigonum vesicæ by dividing the vesico-vaginal wall in a longitudinal direction.

The ureters in the male can be catheterized by Simon's method, in which the bladder is entered through a median perineal incision. The simplest way is to open the bladder by suprapubic cystotomy, and then perform catheterization. Fenwick invented a new method for collecting the urine from one or the other kidney separately in males also. His method is based upon the fact that after evacuation of the bladder the sphincteric action of the muscular fibres of the ureters is impaired in consequence of the relaxed condition of the bladder wall as well as that suction is exerted upon the urine in the kidneys. After the bladder has been emptied and a twenty-per-cent solution of cocaine

has been applied to it, Fenwick introduces a special catheter with a long beak bent to the right or the left and a very long aperture on the side. The latter lies over the orifice of the involved ureter when the instrument is pressed against the posterior wall of the bladder. If aspiration is now made by means of a bulb which is provided with a glass receiver, a sufficient quantity of urine is obtained in about ten minutes.

The inspection of the orifice of the ureter is best accomplished by means of Nitze's cystoscope (see § 205, page 281). We may, perhaps, yet succeed in combining cystoscopy with catheterization of the ureters.

The attempt has been made in males to shut off temporarily one ureter or the other, in order to be able in this way to examine the urine from one ureter or kidney, but these methods—e. g., of Silbermann, Tuchmann, and others—are very uncertain. Tuchmann recommended seizing the mucous membrane in the vicinity of the ureter with a lithotrite-shaped, smooth-beaked instrument, and thereby occluding the orifice. P. Müller recommends compressing the ureter of the male from within the rectum and that of the female from within the vagina. In performing digital compression of the ureter in the male from within the rectum, P. Müller uses as a guide the spine of the ischium, moves the finger from there about four centimetres upward toward the *linea innominata*, and presses it against the soft parts of the lateral pelvic wall—that is, in about the region of the inner wall of the acetabulum, where the ureter lies close to the bony wall of the pelvis. The ureter in the female can be compressed at the same place from within the vagina. P. Müller has constructed a special instrument for instrumental compression (see *Deutsche med. Wochenschrift*, 1887, No. 31). In order to compress the ureter through the abdominal wall, Müller recommends the use of a pad with the patient in a lateral position and fully under the influence of an anæsthetic. The pad is similar to that which is used for compression of the aorta (see *Principles of Surgery*, page 53).

The chief object in catheterizing the ureters is to secure full information as to the condition of a kidney—e. g., when the other is diseased. In case of stricture also or occlusion of the ureter—by renal calculi, for instance—exploration of the ureters may be resorted to. In case of the extirpation of a tumour in the vicinity of the ureter—a tumour of the uterus, for instance—one can inform himself in this way as to the location of the ureter. One may also obtain secretion from each kidney separately by the above-described artificial closure of one ureter or the other for a time. Fenwick believes that he arrested hæmorrhage from the kidney in one case by closing the ureter according to his method.

Ureterotomy, or incision of the ureter, may be indicated in case of incarceration of a stone in the ureter. Tuffier, upon the ground of his own experiments, recommends a longitudinal incision. After the stone has been found and extracted, the longitudinal incision is closed by fine Lembert sutures. Küster cured a very narrow cicatricial stricture of the ureter by resection of the involved part. Before suturing the two ends of the ureter it is a good plan to invaginate them.

For fistulæ of the ureter, see § 256. In case the ureter is wounded, Le Dentu, Agnew, and others recommended, in place of nephrectomy, implantation of the end of the ureter in the lateral or posterior abdominal wall. Such external fistulæ are, however, very likely to lead by infection to severe inflammation of the kidney (Gordano). For implantation of the ureter in the bladder and intestine, see page 17.

§ 202. **Nephrotomy**.—Incision of the kidney, or nephrotomy, is indicated especially, as we have seen, in hydronephrosis and pyonephrosis, as well as in connection with echinococcus, cystic degeneration of the kidney and tuberculosis, and for the removal of renal calculi. In nephrotomy the kidney is exposed by a longitudinal incision along the outer border of the sacro-lumbalis muscle, from the lower border of the eleventh rib to a point about midway between the twelfth rib and the crest of the ilium, or by a transverse incision beneath the twelfth rib, from the outer border of the sacro-lumbalis muscle to the prolonged anterior axillary line, just as in nephrectomy (see pages 270–272). After exposing the kidney or a pus sac or a cyst in this way it is incised, and one then proceeds according to the particular case. The kidney, especially when it appears outwardly to be sound, should always be incised longitudinally—that is, in the same manner as is done at autopsies, because in this way no large branches of the vessels of the kidney are wounded, a thing which is to be feared in a deep radiating incision (A. Barth). In case there is a sac filled with pus, it is preferable to evacuate it first with a trocar. The sac is then freely opened and packed with iodoform gauze, after its wall has been fixed by a few sutures to the edges of the wound. In case of a very large hydronephrosis or echinococcus cyst, it is sometimes a good plan to make the skin incision farther forward—in the axillary line, for example—because more room is secured here. The parietal peritonæum is detached and pushed to one side. If the peritonæum is to be opened, the operation should be divided into two steps, as in echinococcus of the liver—that is, the abdominal wound is packed with gauze and the sac opened from three to five days later after it has become adherent on all sides in the abdominal wound. A posterior counter opening

should always be made in such cases in the lumbar region, and a drainage-tube or gauze inserted.

Küster's method of performing nephrotomy is also a good one, especially for large cysts. The incision begins midway between the twelfth rib and the crest of the ilium at the outer border of the sacrolumbalis muscle, and then runs in a horizontal direction parallel to the iliac crest for ten or twelve centimetres toward the linea alba. The outer border of the latissimus dorsi muscle, the abdominal muscles, the lumbar fascia, and the outer border of the quadratus lumborum muscle are divided by layers. The posterior branch of the first and second lumbar nerves is severed, and the branches of the first lumbar artery are tied. After division of the transversalis fascia the capsule of the kidney lies exposed. It is incised and detached somewhat and the sac is then opened. In case of infectious contents, this is best done with a trocar. After opening the sac freely, its wall is sutured to the edges of the skin and the sac itself is packed with iodoform gauze. A posterior counter opening is often necessary here also.

§ 203. **Nephrectomy.**—Nephrectomy, or extirpation of a kidney, which was first successfully performed by G. Simon in 1871, must only be undertaken when the other kidney is sound, so that it can assume the function of the extirpated organ. Nephrectomy is indicated: 1. In case of injury of the kidney with rupture of the parenchyma and severe hæmorrhage, or in case of prolapse of the organ. 2. In case of injuries of the ureter and in fistulæ of the same that can not be cured in any other way. 3. In case of disease of the kidney (abscess, calculus, malignant tumours). Nephrectomy should be undertaken for floating kidney only in exceptional cases—that is, when the organ is otherwise diseased (see § 195, page 240). If the other kidney is diseased, or if the two kidneys are abnormally united, forming a so-called horseshoe kidney, nephrectomy is, of course, not permissible. The diseased portion of a horseshoe kidney may, however, be successfully removed (Socin). It is not always easy to make sure that the other kidney is normal. The best way of determining this consists in catheterization of the ureter, a procedure which is easily accomplished in females, but which is very difficult in males (see also § 201, pages 267, 268). Kocher palpates the other kidney through the nephrectomy wound by opening the peritonæum alongside the colon. After palpating the kidney, the peritonæum is sutured and nephrectomy performed. In case of suspicion that one kidney is absent, one may also make an exploratory abdominal incision or an extraperitoneal lumbar incision. The diagnosis of a horseshoe kidney can be made, according to Simon and Nussbaum, by palpation from within the rectum by

introducing the entire hand. A careful examination of the urine is, of course, of the greatest importance in judging of the condition of the kidneys (see § 200, pages 261–266), especially a determination of the amount by weight of urea and extractive bodies. Their permanent diminution contraindicates nephrectomy and all other operative interference upon the parenchyma of the kidney.

Lumbar nephrectomy is to be preferred in most cases, but in exceptional instances, especially in very large, solid tumours, the intraperitoneal, or, more accurately, the transperitoneal method may be chosen. As Schede also emphasizes, one should always be careful in the use of antiseptics in performing nephrectomy, as acute degeneration of the epithelial cells of the remaining kidney has been observed in consequence of their use. The prognosis of nephrectomy, if performed under aseptic methods, is, generally speaking, favourable. In thirty-three cases Czerny had forty-seven per cent of recoveries. Bardenheuer had in thirty-seven cases seventy-three per cent of recoveries.

Lumbar or retroperitoneal nephrectomy is performed as follows: The operation consists of two parts: 1. Division of the covering of soft parts down to the fatty capsule of the kidney. 2. Isolation and enucleation of the kidney, ligation of the vessels and the ureter, and removal of the kidney at the hilum. The patient lies upon the sound side on a roller cushion that is placed beneath, so that the space between the crest of the ilium and the twelfth rib may be increased as much as possible on the side that is to be operated upon. The skin incision runs along the outer edge of the sacro-lumbalis muscle from the lower border of the eleventh rib perpendicularly downward to a point about midway between the twelfth rib and the crest of the ilium. The soft parts are now divided by layers from the lower border of the eleventh rib downward for the whole extent of the wound, beginning with the lower edge of the latissimus dorsi muscle and the posterior layer of the lumbar fascia. The outer border of the sacro-lumbalis muscle which now lies exposed is then retracted toward the median line and the anterior layer of the lumbar fascia, the quadratus lumborum muscle and the transversalis fascia are divided. Before dividing the quadratus lumborum muscle and the transversalis fascia, both the twelfth intercostal and the first lumbar arteries, which cross the field of operation, must be tied in two places. The last intercostal and the first lumbar nerves are cut. After division of the transversalis fascia the fatty capsule of the kidney appears, and the kidney, which can usually be felt through the fatty covering, is now isolated bluntly with the fingers. A diseased kidney is especially difficult to isolate in consequence of the firm adhesions that often exist. It may be necessary, on account of

the vessels to be found in these, to tie the adhesions in two places before cutting them. Such firmly adherent kidneys may often be more readily isolated by dividing both the fatty and the fibrous capsule, and enucleating the kidney inside the latter with the fingers. Associated injuries, especially of the colon, are most surely avoided in this way. The isolation of the upper end of the kidney behind the tenth and eleventh ribs may be so difficult as to make subperiosteal resection of the twelfth rib necessary. In performing the latter, one must be on his guard against injuring the pleura. Such injuries are most likely to occur in case of absence or rudimentary development of the twelfth rib, so that the eleventh rib is mistaken for the twelfth. Injury to the pleura is most surely avoided by resecting only the anterior quarter of the twelfth rib, and, it may be, of the eleventh also (Le Dentu). This anterior portion of the eleventh and twelfth ribs is not covered by the parietal pleura, which posteriorly extends down as far as the inner surface of the twelfth rib. The pleura is usually protected, however, by firm adhesions when resection of a rib is necessary.

After isolation of the kidney on all sides, which should be performed with great care, especially at the hilum, on account of the vessels, it is drawn out of the wound. An aneurism needle threaded with a double silk ligature of moderate size is passed through the middle of the pedicle, the latter is tied in two sections by ligatures *en masse*, and the kidney is then removed in front of the ligatures. Some kidney tissue should be left behind on the pedicle so as to prevent the ligatures from slipping. In order to be sure of the pedicle, a final ligature *en masse* around the whole of it may be added to the first two ligatures, or the vessels may be tied separately. The wound is left open and packed with iodoform gauze.

Simon's method has of late been variously modified. Bruns and Linser make the skin incision farther forward, not like Simon, six and a half centimetres from the spinous processes of the vertebræ, but eight centimetres from them. It extends from the twelfth rib to the crest of the ilium. A transverse incision below the twelfth rib from the outer border of the sacro-lumbalis muscle to the prolonged anterior axillary line, or still farther forward, also gives a good exposure. After opening the peritonæum alongside the colon one can make sure of the presence and the condition of the other kidney by palpation. I prefer, on the whole, this transverse incision. Others have added to Simon's longitudinal incision a transverse incision along the twelfth rib. Bardenheuer recommends for cases where the field of operation must be made freely accessible, a longitudinal lumbar incision with a transverse incision above and below. For Küster's method the reader is referred to page 270. For the sake of making the field of operation even more accessible, in case of large renal tumours, for instance, Czerny recommends a slightly curved incision which runs from the tip of the twelfth rib obliquely

forward and downward. Bergmann makes an incision from the tip of the eleventh rib obliquely forward and downward as far as the boundary between the outer and middle thirds of the abdominal wall. All these methods give a good exposure of the field of operation. The parietal peritonæum is either detached bluntly and pushed to one side, or, if necessary, divided, so that the operation becomes intraperitoneal, as for other large abdominal tumours. König distinguishes between his "retroperitoneal" and "retro-intraperitoneal lumbo-abdominal" incision. In the former he divides the soft parts perpendicularly downward from the twelfth rib along the border of the erector spinæ to a point some centimetres above the ilium. The incision continues from here in a curve toward the umbilicus as far as the outer border of the rectus muscle, or, if necessary, to the umbilicus. Along the posterior perpendicular incision the different layers are divided, as described above, down to the fatty capsule of the kidney, while along the horizontal incision the muscles are divided down to the peritonæum. To facilitate suture of the edges of the muscles, and to prevent the development of a ventral hernia by making sure of a solid muscular cicatrix, strong catgut or silk sutures are inserted at once through the cut edges of the muscles and tied at the completion of the operation. The parietal peritonæum is detached with the fingers according to necessity and pushed forward. If it proves necessary to open the peritonæum, this is done along the horizontal part of the incision at its point of reflection ("retro-intraperitoneal lumbo-abdominal" incision). The development of a ventral hernia is prevented by suturing the soft parts by layers.

The extirpation of a floating kidney, which should be undertaken only when the organ is otherwise diseased, has been described in § 195, page 240.

In case of large renal tumours I recommend the performance of intraperitoneal or transperitoneal nephrectomy as follows: After the peritoneal cavity has been opened in the linea alba or on one side of it, or by means of Péan's transverse incision, the tumour is enucleated as completely as possible and isolated from its covering of peritonæum, fascia, and fat, in part with the knife and in part with the fingers, until its pedicle, consisting of the vessels and ureter, is reached. After tying the vessels and the ureter and removing the tumour, the peritoneal cavity is closed, and further treatment of the retroperitoneal wound is usually unnecessary after careful arrest of the hæmorrhage. I emphasized, however, on page 259, that even large renal tumours can be removed very easily through the lumbar incision, and that the intraperitoneal or transperitoneal operation is justifiable only in exceptional cases.

The behaviour of the remaining kidney after nephrectomy has been determined clinically as well as experimentally. After every nephrectomy a very decided diminution, or even an almost complete suspension, of the secretion of urine is observed, but it increases again in the course of the

next four to six days to its normal amount. After nephrectomies in animals—e. g., rabbits—distinct signs of degeneration of the renal epithelium are demonstrable during the first few days, and about five or six days later beginning signs of regeneration are visible (Enderlen). These signs of regeneration are visible in dogs on the second day (author). Every nephrectomy is followed by a compensatory hypertrophy of the remaining kidney, which is demonstrable in dogs, according to Tuffier, macroscopically and microscopically, forty-eight hours after the operation, and completed after from ten to fourteen days. This increase in the volume of the kidney, which has also been observed in man in the same way, depends, according to Tuffier, Kümmell, and others, in part upon hypertrophy and in part upon new formation of glomeruli. Only a perfectly healthy kidney is capable of regeneration, not a diseased one. In dogs with a kidney weighing thirty to forty grammes the increase in weight amounts, according to Tuffier, to one gramme per day. For one kilogramme of weight about one and a half grammes of functioning kidney tissue is necessary, or for an adult about one hundred grammes in all. The new formation of glomeruli which is claimed by Tuffier, Kümmell, and others, is questioned by Barth. He found a compensatory hypertrophy, but never a re-creation of new kidney tissue.

As I have shown by experiments upon animals, and as has been proved by Czerny, Kümmell, Bardenheuer, and others, one may also make partial extirpations or resections of a kidney—e. g., wedge-shaped excisions for the removal of circumscribed foci in the cortical substance. The hæmorrhage is arrested by deep catgut sutures, by use of the thermo-cautery, by packing, etc. An observation made by Czerny shows that even large defects in the kidney heal by granulation in spite of the pelvis of the kidney being freely opened. Hypertrophy of the remaining kidney tissue is observed after resection of a kidney, just as after nephrectomy, and this shows itself in the kidney which has been operated upon as well as in that which is intact (De Paoli), but no new formation of secreting tissue is seen to take place (Barth, the author).

Cicatrization after wounds of the kidney is brought about by the endothelial cells of the intertubular capillaries, the adventitia of the vessels, and the fixed connective-tissue cells of the fibrous capsule (Barth, the author).

Socin successfully removed the diseased part of a horseshoe kidney. The diseased half was separated with the thermo-cautery through the connecting piece, which was four centimetres in width and two centimetres thick, five spurting vessels were tied, and the bleeding surface was covered over with the capsule of the kidney. The patient was completely cured.

CHAPTER XXIII.

INJURIES AND DISEASES OF THE MALE BLADDER.

Examination of the bladder.—Catheterization.—Description of the different catheters.—Other methods of examination.—Cystoscopy and urethroscopy.—*Congenital* deformities of the bladder: Exstrophy, supernumerary bladders, absence of the bladder, smallness of the bladder, closure of the bladder.—Congenital abnormal communication of the bladder.—*Acquired* deformities of the bladder: Dilatation, diverticulum, cystocele.—Injuries.—Inflammatory processes.—Cystitis, tuberculosis, etc.—Vesical fistulæ.—Hypertrophy and atrophy of the bladder.—Inflammatory processes in the space of Retzius; hygroma.—Neuroses (spasm, neuralgia, paralysis of the detrusor and sphincter muscles, enuresis nocturna).—Retention and incontinence of urine.—Puncture of the bladder for retention of urine.—Brainard's posterior catheterization.—Foreign bodies.—Vesical calculi.—Lithotrity.—The different varieties of lithotomy.—Tumours of the bladder.—Resection and extirpation of the bladder.—Artificial substitute for the bladder.

§ 204. **Catheterization.**—The introduction of a sound or catheter into the male bladder is a very common procedure, which is undertaken mainly for examination of the urethra and the bladder or for evacuation and irrigation of the latter.

Catheters are either made of metal, especially silver, or they are soft and flexible, so that they can be given any desired form. Of the soft flexible variety, mention should be made especially of the reddish-brown English catheter, which is provided with a firm, flexible wire, the so-called stylet; the black French catheter, and the brick-red American catheter. By means of the stylet the English soft catheter may be changed into a stiff one of any desired form. A stylet of this sort can be introduced into any soft catheter, which is then given any desired curve. The hardness of the English catheter can be diminished by placing it in warm water. It is largely a matter of individual taste which kind of soft catheter is preferred, but there is no doubt that the English catheters are more durable than the French. The softest catheter is the one recommended by Nélaton, which is made of vulcanized rubber. Injury to the urethra is impossible with Nélaton's soft-rubber catheter, and for many purposes it can not be replaced by any other. It also can be changed into a stiff catheter of any desired curve by the introduction of a stylet. One should not use old Nélaton catheters, as they may break when being introduced or withdrawn. Every catheter should be tested before use; the rubber catheter, for example, being drawn out to determine the degree of its elasticity.

Shape of the Catheter.—All elastic catheters are straight except Mercier's, which is curved as shown in Fig. 519, *a*. Mercier's catheter with a double curve (Fig. 519, *b*) will be spoken of under Hypertrophy of the Prostate.

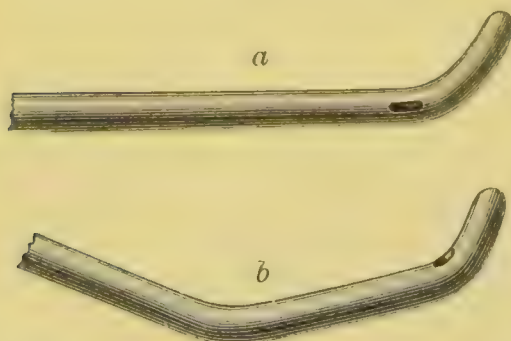


FIG. 519.—Mercier's catheters: *a*, *coudé*; *b*, *bicoudé*.

The stiff catheters are curved to correspond to the anatomical course of the male urethra. Either the beak end of the catheter is alone curved (Fig. 520, *a*), or the catheter is S-shaped (Fig. 520, *b*).

The catheter with a single curve is the most useful, and in this the radius of the curve should become gradually smaller toward its end. Hueter's flat catheter has never been generally used.

Every catheter consists of a straight portion or shaft, of which the front end or "pavillon" is provided with two rings. The curved portion or beak usually has one or two openings or eyes on the side. Some catheters, such as those used for irrigating the bladder,

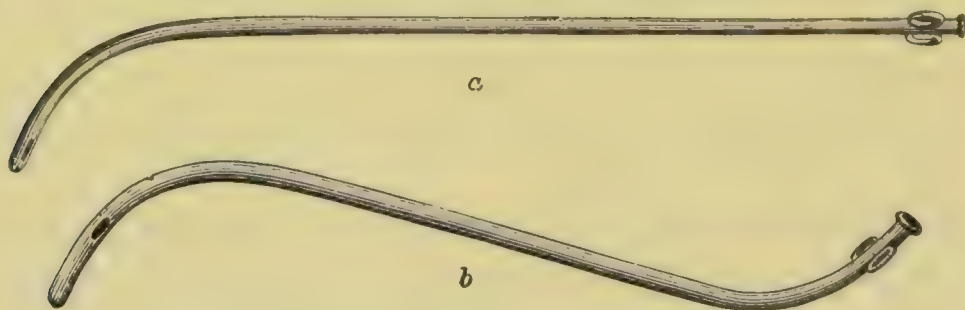


FIG. 520.—Metallic catheters: *a*, Desault's; *b*, Le Petit's.

are "double-current"—i. e., they have an afferent and efferent tube. I never use these double-current catheters for irrigating the bladder, but use either an ordinary catheter or irrigate without a catheter (see page 294).

Catheters which do not form a hollow tube but are solid are called sounds when they are made of metal (Fig. 522), and bougies when they are soft and



FIG. 521.—Double current catheter.

elastic. The tips of urethral sounds and bougies are either cylindrical, conical, bulb-pointed, or spindle-shaped (Fig. 523).

The length and circumference of metallic catheters vary

with the age of the patient or the length and circumference of the urethra. The length of the urethra in an adult is from twenty to twenty-two centimetres (Henle). The catheter should of course be several centimetres longer than the urethra. According to the size of catheters, we have in the French scale thirty numbers. The lowest number has a diameter of one third of a millimetre, and the highest a diameter of one centimetre. Each number is one third of a millimetre larger than the preceding. Pocket cases usually contain catheters that have been taken apart and may be fitted together again.

In using these one should be very careful that the piece within the bladder does not break off at its point of union with the rest of the instrument.

For a description of female catheters I refer to § 253 (Surgery of the Female Urethra and Bladder). It need only be mentioned here that they are much shorter than the male catheters, and are straight or only slightly curved.

Introduction of a Catheter.—Strict antisepsis must be observed in the introduction of catheters. Every catheter should be-

fore use be carefully cleansed and sterilized. Metallic catheters are sterilized by boiling them for from three to five minutes in a one- to two-per-cent soda solution or in water, while those made of rubber or similar material may be subjected to the action of steam—in Kutner's apparatus, for instance. By the use of dirty, unsterilized catheters catarrhal inflammation of the bladder may easily ensue, and not infrequently severe suppurative inflammation of the bladder and kidney has resulted which in some cases caused the death of the patient. Before being introduced, the catheter or bougie should be smeared with aseptic oil, vaseline, lanolin, or, best of all, with a two- to three-per-cent solution of boric acid in glycerin, in order that it may glide easily through the urethra without any friction. Moreover, the catheter or bougie should be previously warmed by rubbing it with a clean cloth or placing it in a lukewarm three-per-cent solution of carbolic acid, as a cold catheter is very unpleasant for the patient.

The usual stiff metallic catheters are introduced as follows: The surgeon stands on the patient's left, and, grasping the penis with his left hand, raises it over the symphysis toward the abdominal wall so that the urethral orifice is directed upward. In this way the direction of the urethra is made to correspond with the curve of the instrument. The well-oiled aseptic catheter is then held with the thumb, forefinger, and

middle finger of the right hand in such a way that the curve of the catheter or its beak is directed downward and it is then introduced into the external meatus. The catheter is now pushed slowly and cautiously along the urethral canal, and at the same time the penis is drawn over the catheter, thus smoothing out the folds of the urethra. During this procedure the catheter is usually held in the median line of the body. The penis should be pushed over the catheter until the point of the latter has reached the bulbous portion

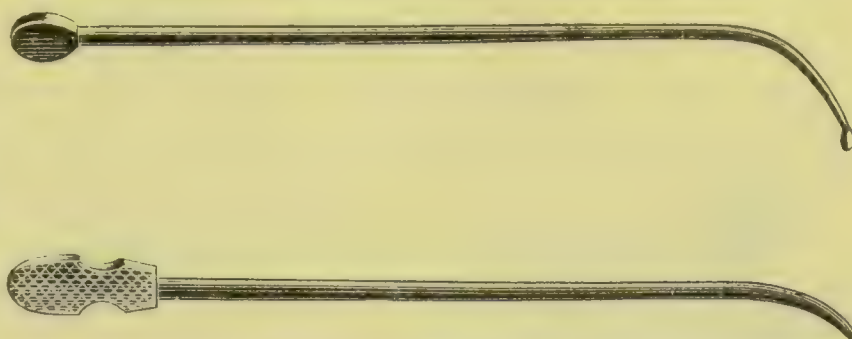


FIG. 522.—Urethral sounds.

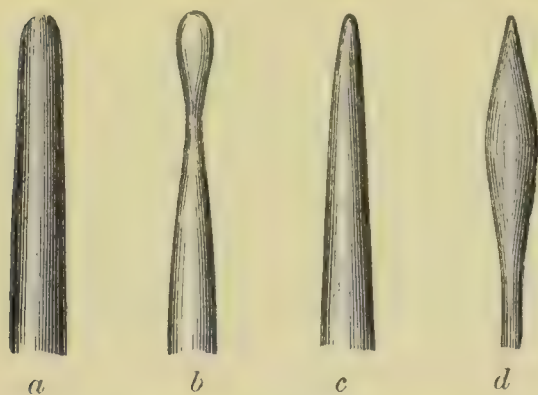


FIG. 523.—*a*, cylindrical; *b*, bulb-pointed; *c*, conical and *d* spindle-shaped bougies.

of the urethra (Fig. 524). The outer end of the catheter is now made to describe a curve of one hundred and eighty degrees downward by lifting the penis from the abdominal wall, so that it is at first vertical and then

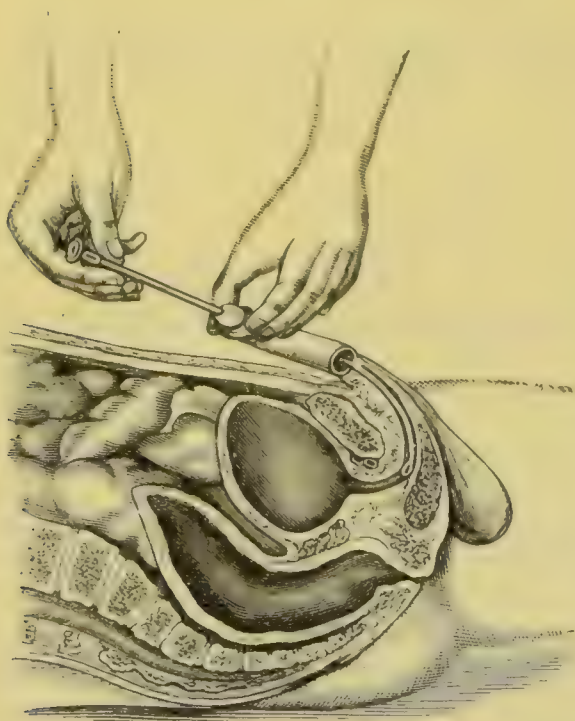


FIG. 524.—Introduction of a male catheter.

gradually becomes horizontal. By lowering the handle of the catheter still farther, somewhat below the horizontal, its beak glides through the neck of the bladder into the bladder itself. The escape of urine from the catheter shows that the latter has entered the bladder. Catheterization should be performed in a gentle manner, without pressure, without pain, and without hæmorrhage. One should bear in mind that the catheter should, as it were, find its own way into the bladder.

In the removal of a catheter the same movements are made in reversed order. The opening of the catheter should be closed with the index finger, in order that the urine that is in the catheter may remain there and not soil the patient.

In introducing soft catheters and bougies the penis should be held upright and gentle traction made upon it. Soft catheters are very frequently introduced with the penis in a horizontal position, the latter being drawn straight forward. The soft catheter is grasped near its distal end, in order that it does not bend upon itself, and is pushed carefully into the urethra, or rather the penis is drawn over it. If a soft

catheter has been converted into a stiff one by the insertion of a stylet, it is then introduced in the same way as a metallic catheter. After such a catheter has been introduced the stylet is withdrawn in order that the lumen of the catheter may be free. If one wishes to leave a soft catheter in the urethra for some time, its outer end is

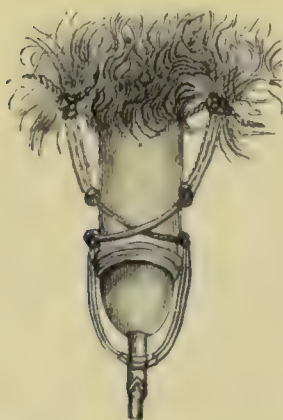


FIG. 525.—Method of securing a permanent catheter with silk thread.



FIG. 526.—Method of securing a permanent catheter by means of a bandage of rubber strips.

closed with a small plug of wood or by a clamp, and the catheter itself fastened by means of silk thread (Fig. 525) or a bandage (Fig. 526). In place of the latter I use at present a round rubber disk, and fasten the catheter to

the penis in adults by means of silk threads, strips of bandage, or adhesive plaster. In children I fasten it to the pelvis. A permanent catheter should be made of soft rubber, and should not be pushed too far into the bladder, as it may irritate it too much. The tip should reach into the neck of the bladder but no farther. Guyon recommends for continuous catheterization catheters made of pure India rubber with a large lumen.

Obstacles, Mistakes, and Dangers in Catheterization.—The obstacles to catheterization of a normal urethra occur for the inexperienced mainly at the membranous portion, the prostatic portion, and in the neck of the bladder, because very often the catheter is lowered too soon or too late. The catheter is frequently arrested, because the subpubic curve of the urethra is circularly constricted by the triangular ligament, and in front of this the lower urethral wall corresponding to the bulb has a pouchlike dilatation (*golfé uréthral* of the French). Moreover, there is an apparent obstruction at the termination of the prostatic urethra in front of the neck of the bladder; here also the wall of the urethra has a shallow, pouchlike depression. In consequence of these pouches on the lower wall of the urethra, the beginner should make it the rule to keep close to the upper wall in introducing the catheter. Other obstacles to catheterization are dependent upon oversensitiveness of the patient or the urethra, and especially upon spasm of the constrictor muscle of the bladder. This spasm of the sphincter vesicæ prevents the entrance of the catheter into the bladder, and is not infrequently mistaken for a stricture. In case such a spasm of the sphincter is present, one should wait a while, and not push the catheter farther until the spasm is over, after which it can usually be made to enter the bladder without any difficulty. In the case of very sensitive patients it is a good plan to give beforehand a hypodermic injection of morphine or to inject cocaine into the urethra; catheterization is then much easier. In very nervous patients, in young children, and under difficult circumstances an anæsthetic is sometimes necessary. Other obstacles to the passage of a catheter are caused by strictures, foreign bodies, tumours of the prostate, injuries, etc.

One serious mistake made in catheterization which often prevents a successful accomplishment of the same consists in bearing too much weight on the catheter with the hand. He who has a gentle touch can show this to the best advantage in the passage of a catheter in which careful manipulation is absolutely necessary. It is also a mistake in technique when the penis is not pushed far enough over the catheter so that the urethra is not smoothed out sufficiently by elongating the penis. On the other hand, it is a mistake to pull too much

and too forcibly on the penis, because in this way again arrest of the tip of the catheter in the sinus of the bulb and in front of the neck of the bladder is favoured.

Other Consequences and Accidents from Catheterization.—The careless introduction of a catheter may cause perforation of the urethra (false passage, see Fig. 527). Such false passages are rare in the case of

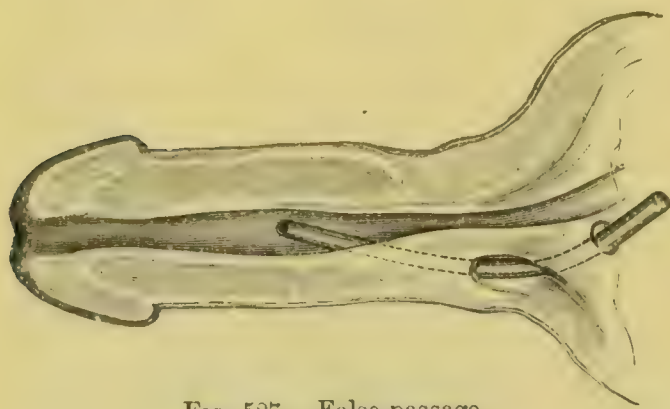


FIG. 527 —False passage.

a normal urethra, and are only possible from rough catheterization. Injuries of the urethra are most common in strictures and in hypertrophy of the prostate. False passages occur most frequently in the membranous and prostatic urethra. Every injury to the urethra is accompanied by corre-

sponding hæmorrhage, and should always be regarded as a serious occurrence which may lead to an abscess, a phlegmon in the vicinity of the urethra, and even to death from sepsis. I recently saw a case of false passage made by a quack which resulted in malignant œdema of the perinæum and scrotum that spread rapidly to the lower extremities, and caused the death of the patient in a few days from acute sepsis. Catheterization is sometimes followed, especially in the case of nervous individuals, by the so-called urethral fever, even though the urethra has not been injured. Patients of this sort with urethral fever complain at the conclusion of a catheterization of a chilly sensation or a marked chill, and not infrequently their temperature rises to 40° C. (104° F.) and over. Frequently one observes a chill without a subsequent rise of temperature. Some of these cases of urethral fever depend probably upon a transitory systemic infection, due to the introduction of an unsterile catheter. In other cases we have to do with a reflex rise of temperature in consequence of irritation of the sensory nerves of the urethra. In exceptional instances the passage of a catheter has been known to cause death from reflex paralysis of the heart in very nervous, anxious individuals. Other operations have caused death in the same way, even before the administration of the anæsthetic, in consequence of fear and nervous excitement.

§ 205. **Other Methods of Examination of the Urethra and Bladder.**—Direct visual examination of the urethra and bladder, so-called endoscopy, has only been employed to any extent in recent years. Visual examination of the urethra is called urethroscopy, and of the bladder,

cystoscopy. Desormaux was the first to develop urethroscopy and cystoscopy into definite methods (1853–1865). At the present time

Nitze and Leiter have been the most instrumental in perfecting these methods of examination. A great advance was made when Nitze and Leiter devised their electric endo-

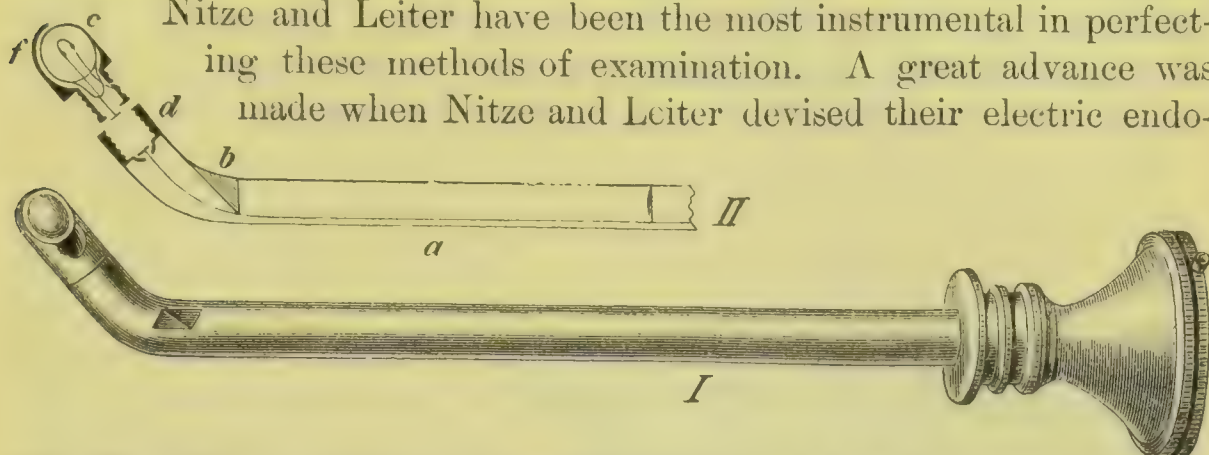


FIG. 528.—*I*, Nitze's cystoscope. *II*, Longitudinal section of *I*; *a*, shaft; *b*, prism; *c*, incandescent light which is fastened into the small compartment *f*.

scopes, in which the light is within the instrument itself and is carried into the urethra and the bladder. By means of these instruments, which quickly took the place of all other forms of apparatus, the direct inspection of the urethra and bladder is rendered possible in a very satisfactory manner. Nitze has won lasting credit in the development

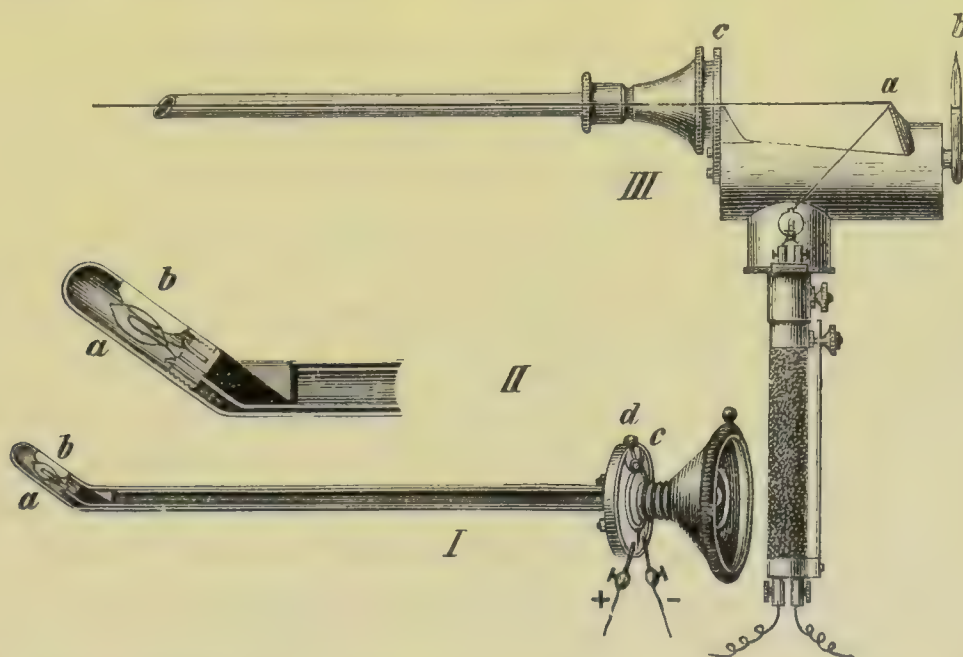


FIG. 529.—Leiter's cystoscope. *I*, Longitudinal section; *a*, metallic compartment and electric light; *b*, depression for the window; *d*, mechanism for closing the current. *II*, The same on a large scale. *III*, Electro endoscope for illumination of the external auditory meatus, the œsophagus, and the urethra; *a*, obliquely placed concave mirror which reflects the rays from the incandescent light in the tip of the instrument into the opening of the tube at *c*; *b*, correcting lens for persons with myopia and hypermetropia.

of cystoscopy and urethroscopy, and the instruments invented by him are probably the most serviceable. Nitze's electric endoscope contains a small, incandescent lamp, six and two thirds millimetres in length,

which is fastened into the silver end compartment in such a way that the compartment and lamp form a whole (Fig. 528). An oval window allows the rays from the lamp to emerge without hindrance. At its base the end-piece is provided with a screw. In Figs. 528 and 529 are represented the electric endoscopes of Nitze and Leiter. For a more exact description of the same, the reader is referred to the *Centralblatt für Chirurgie*, 1887, No. 25, pp. 85-91 (Congress edition). Next to Nitze, Deicke (in Berlin) deserves great credit in the construction of electric endoscopes. Endoscopy with the instruments of Nitze and Leiter still offers the greatest advantages. By means of the same, it is possible to see at one time a portion of the inner surface of the bladder larger than a silver dollar, and by moving the instrument about, the whole surface of the bladder can be brought into view. The recently invented arrangement for irrigation is of great advantage, by means of which the depression for the window near the tip of the instrument can be freed from any blood or mucus that may adhere to it and obstruct the view. Urethroscopy and cystoscopy have for the examination of the urethra and the bladder the same diagnostic value as rhinoscopy and laryngoscopy for the examination of the naso-pharynx and larynx. No little practice is, however, necessary before that which is seen can be correctly interpreted. Of late, operating cystoscopes have been constructed—i. e., small scissors, a knife, a hook, etc., have been attached in order to make it possible to operate within the bladder with the aid of an electric light (Hartwig).

Examination of the urethra and bladder by means of sounds has already been mentioned under Catheterization (page 275). By the introduction of sounds one is able to gain information as to the size of the urethral canal. Stone-searchers will be described under the subject of Vesical Calculi. One should never omit percussion of the hypogastric region in examination of the bladder. Palpation is also of great importance. Palpation of the urethra from the outside is especially valuable in case of changes in the urethra due to the presence of inflammatory processes, fibrous strictures, concretions, foreign bodies, etc. The prostate and bladder are palpated from the rectum. Finally, bimanual examination is useful in many diseases of the bladder. One passes the forefinger into the rectum and presses the bladder with the other hand backward and downward toward the rectum. For a description of rectal palpation with the whole hand as practised by Nussbaum and Simon, see § 170, page 134. The interior of the bladder is frequently rendered accessible to palpation and inspection by means of perineal section or suprapubic cystotomy. The latter operation offers the greatest advantages in this respect.

§ 206. **Congenital and Acquired Deformities of the Bladder.**—The malformations of the bladder and urethra, especially the fissure formations, are mainly the result of arrested development in a very early period of foetal life (Reichel). The most important deformity of the bladder is exstrophy (ectopia or *inversio vesicæ*, Fig. 530). In this condition the anterior wall of the bladder and the corresponding portion of the abdominal wall are absent. The dark-red

mucous membrane of the posterior wall of the bladder lies exposed in the region of the symphysis in the form of a round tumour. The posterior vesical wall is continuous laterally with the somewhat cicatrized skin of the abdominal wall. The size of the tumour varies with the degree of the defect and the age of the patient. In a full-grown person it not infrequently reaches the size of a fist. In the lower half of the tumour one finds the orifices

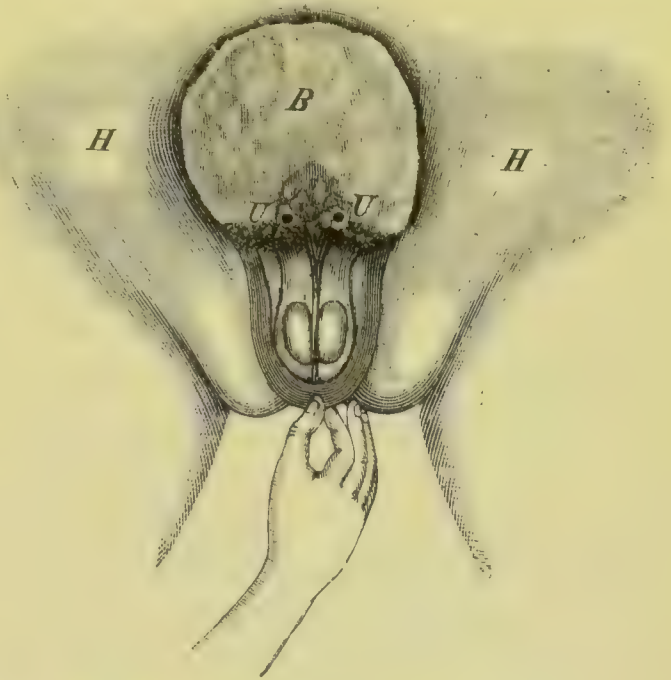


FIG. 530.—Exstrophy of the bladder combined with epispadias: *B*, posterior wall of the bladder; *U*, orifices of the ureters; *H*, inguinal hernia on each side.

of both ureters from which urine exudes in drops (Fig. 530, *U*). In male patients exstrophy of the bladder is almost always combined with fissure of the upper wall of the urethra (epispadias), and with rudimentary development of the penis (Fig. 530). In female patients the clitoris is also divided.

In fully developed cases of exstrophy the symphysis is absent, and there is usually diastasis of the recti muscles which sometimes extends to the umbilicus. Other abnormalities include double inguinal hernia, incomplete development of the testes, cryptorchismus, and division of the scrotum into two halves, so that they resemble the labia. This explains the fact that, especially in the country, the sex of such children is not recognised at birth, and they are given a boy's and girl's name when baptized. Not infrequently the seminal vesicles and prostate are absent, while in females the vagina and uterus may be double. Finally, mention should be made of a defective formation of the pelves of the kidney and of the ureters, deformities of the rectum such as imperforate anus or rectum, absence of the large intestine or other por-

tions of the intestinal tract, and the presence of an abnormal anus of the small intestine above the prolapsed posterior vesical wall or between the two divided halves of the same. Martini observed an abnormal opening of the descending colon into the posterior bladder wall in a case of imperforate anus and urethra. Exstrophy of the bladder is much commoner in the male than in the female sex. We distinguish, with Winkel, three degrees of exstrophy: 1. Defect of the lower portion of the bladder with closed symphysis (*fissura vesicæ inferior*). 2. Defect of the upper portion of the bladder with closed symphysis (*fissura vesicæ superior*). 3. Absence of the anterior bladder wall, overlying abdominal parietes, and symphysis pubis with cleft of the external genitals (*eversio et ectopia vesicæ*). *Fissura vesicæ inferior* has been observed in a large number of cases, but concerning *fissura vesicæ superior* very little can be found in literature.

The disturbances in exstrophy consist in the constant dribbling of urine, which results in the clothing being wet most of the time, thus causing a very foul odour. The patients are deprived of the enjoyment of every pleasure in life, so that they are to be very much pitied. The constant wetting of the skin of the abdomen gives rise very often to eczema and intertrigo, with itching and burning. They are obliged to change their clothing frequently even though they carry a receptacle for urine which is attached to an elastic body belt.

Etiology of Exstrophy and Epispadias.—Several theories have been brought forward for the explanation of exstrophy and epispadias. I mention first the view held by some that exstrophy is the result of foetal retention of urine, due, for example, to atresia of the posterior portion of the urethra, or to an absence of or delay in the formation of the glandular urethra. In consequence of this retention of urine the bladder becomes very much distended, and prevents in this way union of the symphysis. The anterior bladder wall and abdominal wall rupture, and the posterior bladder wall pushes itself forward through the defect. According to another theory, exstrophy and epispadias are malformations due to arrested development, and are supposed to be the result of an abnormal sequence in the coalescence of the pelvis and division of the cloaca. Reichel thinks that exstrophy and epispadias are due to an arrest in development occurring in the first weeks of foetal life, and are the result of disturbance in the formation of the primitive streak—i. e., coalescence of the borders of the primitive groove does not take place or is defective. According to Bartels, the cause of exstrophy lies in abnormal separation of the mid gut from the hind gut in the fourth week. Perls asserts the cause to be the presence of adhesions between the lateral plates and the amnion, while Ahlfeld gives as a reason the rupture of the exposed and distended allantois, whose excretory ducts are for some reason prevented from being formed. Rolgans claims that exstrophy develops at the end of the fourth month of foetal life, mainly in consequence of pressure of the umbilical cord against the anterior abdominal

wall when the former lies between the legs of the foetus. As the result of this pressure, the abdominal wall and the anterior wall of the bladder, which is still situated within the same, are divided from the umbilicus to the region where the perinaeum is formed. That the soft umbilical cord can sometimes exert strong pressure is shown by the occurrence of intra-uterine amputations.

Cases in which an exstrophy and epispadias have healed before birth have been recorded. In a case reported by Küster there was exstrophy of the bladder, the penile portion of the urethra was closed, and on the dorsum of the penis a white cicatrix was visible.

Treatment of Exstrophy.—In order to diminish the annoyance of the patient in consequence of the constant escape of urine, he is made to wear a urinal to receive the urine. Experience shows, however, that it is very difficult for patients to carry and secure properly these urinals, and for this reason it is very desirable to resort to operative measures for a cure of this condition, which otherwise prevents the enjoyment of almost all pleasures in life. Wood, Billroth, Trendelenburg, and especially Thiersch, have won lasting credit in the development of an operative treatment of this deformity.

Thiersch began the operative treatment of exstrophy by curing the epispadias by his own method (see § 217, Epispadias). The defect in the bladder was then covered with flaps of skin. Thiersch cut three skin-flaps. An upper pedunculated skin-flap, large enough to cover the whole defect, was taken from the middle abdominal region and turned downward, so that the skin surface was directed toward the mucous membrane of the bladder. This flap was sutured to the previously freshened borders of the defect. At the same time, two lateral bridge-shaped skin-flaps with a double pedicle were marked out and dissected up from the subjacent tissue. These two flaps, which are connected at their ends with the surrounding skin, remain for the time being *in situ*. Tinfoil, oiled silk, iodoform gauze, or the like, are inserted beneath them, and they are allowed to granulate. After a time these granulating skin-flaps are detached at one end, laid over the granulating first flap, and sutured together in the median line. In this way the anterior wall of the bladder is composed finally of these three flaps of skin. The skinning over of the granulating defects is hastened by means of Thiersch's skin-grafts. Billroth covered the defect with lateral granulating flaps only; a lower and an upper skin-flap are taken, which at different sittings are laid over the defect with the granulating surfaces directed inward. After the epispadias and defect in the bladder have been covered, the patient has a bladder reservoir and can carry a urinal. The place of transition from the interior of the bladder into the canal of the penis can be closed by a pad in order to pre-

vent constant dribbling of urine, as the sphincter is hard to replace (see page 287). This adjustable pad is fastened to a truss, as the patients usually have an inguinal hernia. Many males, after operation, are able to hold their urine for an hour and longer. In order to make a urinal unnecessary by allowing the urine to flow into the rectum, Thiersch, in the case of a girl, brought about necrosis of the vesico-rectal wall by the repeated application of a clamp with plates one centimetre in diameter. Billroth proposed the formation of a permanent fistula in the wall of the artificial bladder reservoir, just as in suprapubic puncture of the bladder. Such fistulæ, after puncture of the bladder, close perfectly tight in consequence of contraction of the recti muscles, and the patients can draw off their urine every five to six hours with a soft-rubber catheter. This closure of the fistula by the recti muscles does not take place in exstrophy of the bladder, because a diastasis of the same exists.

In all cases where the cutaneous surface of the flaps for the anterior vesical wall is directed toward the interior of the new bladder a marked tendency exists to the formation of concretions in consequence of precipitation of the urates, especially on the hairs. This formation of concretions is less marked when a granulating wound surface is directed toward the interior of the bladder. To prevent the annoyance resulting from the formation of concretions, it would be a good plan to provide the skin-flaps with a covering of mucous membrane by transplantation of the same after Wölfler.

Trendelenburg deserves credit for an advance in the operative treatment of exstrophy of the bladder. In order to overcome the separation of the symphysis he divided in young children the sacro-iliac synchondrosis on both sides with a stout scalpel to such an extent as to make the ossa ilei movable. By keeping the children in bed for several weeks with an apparatus that compressed the pelvis laterally, the stumps of the symphysis were forced inward and held in contact. The separation of the sacro-iliac synchondroses in children of three years proved to be a very simple and safe operation. For closure of the defect in the bladder, all that is then necessary is to freshen the borders of the skin and insert a row of silver-wire sutures. Primary union was, however, not obtained, and secondary operations were necessary. Whether by Trendelenburg's operation a useful sphincter can be secured is questionable.

Czerny used the following method, which seems to me a very excellent one: The vesical mucous membrane is dissected up from the periphery toward the centre, and then united so as to form a cavity. This cavity is lined throughout with mucous membrane, which prevents the formation of urinary concretions which are so often present, especially when the hairs of the outer integument lie within the new bladder. The skin defects are covered with two lateral bridge-shaped flaps. At a second and third operation the urethra and neck of the bladder are carefully sutured together (see § 217,

Epispadias), in order to secure a sort of elastic closure of the bladder and aid in the development of the sphincter.

The action of the sphincter can be increased if one proceeds according to Trendelenburg's method for epispadias, and incises freely the upper wall of the urethral orifice and the urethra, and unites the divided edges with Lembert sutures, so that the abnormally wide urethra is considerably narrowed as far as the *orificium internum*. In one case operated on by Trendelenburg in this way the patient was able to retain his urine for from two to three hours. Schlange recommends suture of the edges of the defect in the bladder by detachment of the two recti muscles. He makes an incision about ten to fifteen centimetres in length along the outer border of the recti muscles, detaches them from the horizontal ramus of the os pubis and subjacent transversalis fascia, and, after freshening the edges of the bladder defect, inserts silver-wire sutures. If there is a good-sized bladder present, one should strive to preserve or replace the sphincter muscle by freshening and suturing the edges of the prostatic portion of the urethra which have been made movable.

Sonnenburg extirpated the bladder in an extreme case of exstrophy. The entire posterior wall of the bladder was separated from the peritonæum without opening the latter, and the resulting defect covered by sliding over a flap from the side. The ureters were dissected up from their normal situation and sutured into the dorsal groove of the penis beneath the edges of the skin-flap. The patient's condition was in so far improved that he could carry a simple urinal. Niehans also performed Sonnenburg's operation with an excellent result. Segond dissects up, like Sonnenburg, the posterior bladder wall as far as the entrance of the ureters, but, instead of removing it altogether, turns it down so as to make a covering for the groove on the dorsum of the penis. The glans is stuck through the prepuce, and the latter is healed on to the bladder flap. The defect resulting from the detachment of the mucous membrane of the bladder is covered with two skin-flaps. The urine flows from the ureters into a canal widened above and situated between the groove on the dorsum of the penis and the vesical mucous membrane which has healed over it.

Other Deformities of the Bladder.—The bladder is occasionally divided into two completely separated halves by a more or less marked septum (supernumerary bladder, *vesica bipartita*, seu *bilocularis*). The two halves of the bladder lie side by side, or one over the other. If the latter is the case, the ureters may empty into the upper as well as into the lower compartment. Blasius saw a case in which the bladder was made up of five completely separate cavities. In some cases of apparent multiple bladder we have in reality to do with a rare congenital diverticulum of the bladder behind the trigone.

Complete absence of the bladder, with the orifices of the ureters situated in the urethra, is very rare. Merckel, Blasius, Fleury, and Oliver have seen such cases. The bladder is in other cases abnormally small, or shut off from

the urethra with persistence of the urachus, or shut off from the ureter with congenital hydronephrosis. If the urethra is closed, the bladder may be so distended from retention of urine as to cause an obstacle to birth. In such cases the urachus of the foetus becomes patent again, and the urine escapes through this. The congenital hydronephrosis may likewise prove a serious obstacle to birth.

Mention should also be made of a congenital communication between the bladder and rectum (recto-vesical fistula) or the bladder and vagina (congenital vesico-vaginal fistula). In imperforate anus (see § 171, page 136) the descending colon sometimes empties into the posterior portion of the bladder.

Perviousness of the Urachus.—As is well known, the urachus after birth becomes the median ligament of the bladder. In some cases, however, it remains pervious, to a greater or less extent, either at its middle, its upper and lower end, or in its entire length. If the urachus remains pervious at its middle, a large cyst may develop above the bladder (urachal cyst) which bulges out in the median line of the abdomen, and may be mistaken for an ovarian cyst. We have already described urachal cysts and urachal fistulae on pages 7 and 12.

Acquired Changes in the Form of the Bladder.—Symmetrical enlargement or dilatation of the bladder not infrequently ensues in consequence of retention of urine from stricture of the urethra, hypertrophy of the prostate, or paralysis of the muscular wall of the bladder. In consequence of the increasing distention, the bladder may reach the umbilicus. Complete retention of urine is followed by death from uræmia or rupture of the bladder in case the distended bladder is not emptied by means of a catheter, puncture above the symphysis, or perineal section.

The bladder is occasionally only partially dilated in the form of a diverticulum. These partial dilatations occur most commonly in the posterior wall of the bladder as the result of strictures and prostatic hypertrophy. Either all the layers of the bladder wall bulge out at some particular point, or only the mucous membrane, which has pushed its way through the muscular coat. This is most likely to occur when the bladder wall has become hypertrophied, in which case the mucous membrane bulges out between the muscular bundles, which have separated in consequence of the dilatation. Concretions are not infrequently formed within these sacculi of the bladder, and are called encysted calculi. The sacculi are usually of a moderate size, not exceeding, as a rule, that of a walnut. They may, however, continue to increase in size, resulting in the formation of very large pouches. The entrance into these sacculi is always narrow. They are not infrequently the site of inflammatory processes which may lead to ulceration, or even perforation, and the formation of fistulae in different directions. A portion of the bladder wall is sometimes found within a hernia in the form of a diverticulum, or the whole bladder may be present. The bladder has been found in inguinal, femoral, ischiatic, and obturator herniæ. Among the fifty-six cases of hernia of the bladder collected by Aue, forty were inguinal, eight perineal, three obturator, two femoral and ventral, and one ischiatic. The bladder also frequently prolapses into the rectum and vagina. The bladder may enter a hernia from the fact that the former has to follow the displacement of the peritonæum caused by the traction of the hernial sac, or because of abnormal adhesions

of the bladder, or in consequence of prevesical lipomata, which, by their growth, displace the bladder. Calculi are sometimes found in such herniæ of the bladder. It is characteristic of a hernia of the bladder that it increases in size in consequence of the accumulation of urine, and becomes smaller after urination or catheterization. If both intestine and bladder are within a hernia, the latter usually lies behind the former, and is adherent to the surrounding tissue. Herniæ of the bladder are always acquired. In the case of a strangulated hernia of the bladder, herniotomy is indicated, followed, it may be, by a radical operation. A radical operation is also advisable in all cases of irreducible hernia of the bladder in which the disturbances are sufficiently marked. The technique varies with the case in hand, and it may be necessary to resect the prolapsed portion of bladder and suture the resulting wound. The recognition of a hernia of the bladder is often difficult, and the bladder has consequently been opened by mistake a good many times in hernia operations. Among twenty-seven cases this occurred, according to Manday, twenty times. If one finds alongside the hernial contents a second sac, one should ascertain by the introduction of a sound or catheter whether or not this is the bladder.

§ 207. **Injuries of the Bladder.**—Among injuries of the bladder I mention first subcutaneous contusion and rupture of the same. The latter occurs most frequently in case the bladder is full and the individual falls or is struck upon the abdomen. The posterior wall is most commonly ruptured. Rupture of a healthy bladder from distention without an injury is very rare. It is much more common for a bladder that has undergone pathological changes to rupture from this cause. In case of retention of urine in a healthy bladder, death is more likely to take place from uræmia than from rupture. Occasionally the neck of the bladder is torn from the urethra.

Of wounds of the bladder, punctured wounds are the most common. The bladder can be reached from three directions—from the perinæum and anal region, through the obturator foramen, and through the abdominal wall. The bladder is sometimes punctured by sharp fragments of bone—for example, in fractures of the pelvis, especially fractures of the os pubis and ischium. Severe injuries of the bladder may also be due to impalement (see § 156, page 20). In women during a difficult labour, the anterior vaginal wall and the bladder may be crushed by the presenting part. These contused wounds may heal without disturbances, or they lead, which is the more common, to vesico-vaginal fistulæ. The bladder is occasionally perforated by an ulcerative process in the vesical mucous membrane or its vicinity, especially a sloughing carcinoma of the uterus, vagina, rectum, etc. Among the most unfavourable injuries of the bladder are the gunshot wounds which are usually complicated by fractures of the pelvic bones, and other severe injuries.

It is of prime importance for the course of injuries of the bladder whether the peritonæum is injured or not—i. e., whether or not there is an open intraperitoneal wound. Much depends also upon whether the bladder was full at the time of injury, and whether the urine is normal or, in consequence of inflammation of the bladder, is in a process of decomposition. The most dangerous injury of the bladder is a gunshot wound of the same with injury to the peritonæum, and the most favourable is a subcutaneous injury at a point not covered with peritonæum and with normal urine. The escape of undecomposed urine into the peritoneal cavity is not followed immediately by peritonitis, or, in case of an extraperitoneal injury, by inflammation of the extraperitoneal cellular tissue. Death is more likely to result in these cases from uræmia. The urine, however, that escapes from the bladder into the peritoneal cavity and extraperitoneal cellular tissue decomposes very quickly, especially if micro-organisms gain access to it through the external wound. An intraperitoneal injury of the bladder is then followed by acute septic peritonitis, and an extraperitoneal injury of the anterior and lower portions of the bladder by an acute sloughing phlegmon of the cellular tissue.

The most important symptoms which point to an injury of the bladder are hæmorrhage, emptiness of the bladder, and strangury. The larger the rupture or wound of the bladder, the less likely is bloody urine to be passed through the urethra. The prognosis is best in subcutaneous, extraperitoneal injuries of the bladder, and worst in intraperitoneal and in open wounds which communicate with the external air, whether they be intraperitoneal or extraperitoneal. Of seventy-six patients with extraperitoneal wounds, twenty-nine, according to Maltrait, recovered; and of ninety-six with intraperitoneal wounds, only one was saved by laparotomy. Intraperitoneal gunshot wounds have probably all proved fatal. It follows from this that extraperitoneal injuries have a much better prognosis. In the future, however, the prognosis of intraperitoneal injuries will be much improved by early laparotomy. The fatal outcome of wounds of the bladder is the result usually of sepsis following septic peritonitis, or a septic extraperitoneal phlegmon. The latter not infrequently leads to progressive gangrene. If recovery takes place, the same may be complete or a fistula results—i. e., a narrow abnormal communication between the bladder and the external air or another adjacent organ. Recovery may also take place if the wound in the bladder is closed immediately after the injury by contraction of the muscular coat or if adhesions are formed. Wounds of the bladder are not infrequently followed by secondary disturbances in consequence of the presence of foreign bodies

that are left behind. The latter may give occasion for the formation of vesical calculi. In stab wounds especially, the rent in the bladder wall may be closed by contraction of the muscular coat, and in this way recovery made possible.

Diagnosis of Injuries of the Bladder.—The diagnosis of an injury of the bladder is not easy, especially if the rent in the bladder is small. In making the diagnosis it is important to note the nature and location of the injury; moreover, the presence of bloody urine, strong desire to urinate, and evacuation of a small amount of urine, or even anuria. The latter is particularly likely to be present when all the urine escapes through a large intraperitoneal opening into the peritoneal cavity. In the case of an extraperitoneal wound of the bladder one finds a tumour in the neighbourhood of the bladder containing blood and urine, which may be on one or both sides of the median line. As an aid in the diagnosis, Keen recommends emptying the bladder and injecting hydrogen gas or filtered air into the same by means of a catheter and a Davidson syringe. If the bladder is intact, it appears as a round, elastic tympanitic tumour in the hypogastrium, while otherwise the air escapes into the peritoneal cavity. In the latter case laparotomy should be performed at once. The early diagnosis of an injury of the bladder is of great importance for the treatment.

Treatment of Injuries of the Bladder.—It is of chief importance to ward off the danger which threatens the peritonæum and extraperitoneal cellular tissue from the entrance of decomposed urine and from extravasation of urine. In case of intraperitoneal injury of the bladder one must therefore perform laparotomy as promptly as possible and close the wound in the bladder with Lembert sutures of fine silk or catgut. It is best not to include the mucous membrane in the suture, but to bring together the other layers of the bladder wall by two rows of sutures. Brenner recommends two rows of a purse-string suture (page 322). It is a good plan to leave a soft-rubber catheter in the bladder for the next few days in order that it may remain empty. In extraperitoneal injuries of the bladder and neck of the bladder one must secure in every case a ready escape of urine and the products of inflammation by introducing a permanent catheter into the bladder and combating the paravesical inflammation by incisions and drainage. A permanent catheter is, however, generally inadequate in injuries of the bladder, and it is a better plan to drain the bladder through the peritonæum or above the symphysis. If there is an external wound in conjunction with an injury of the bladder it should be enlarged and drained. One must be on the lookout for any accessory injuries of the pelvis, rectum, etc. In case the bladder and rectum are injured synchronously, it is advisable to divide the sphincter in order that the urine may escape more readily. If a vesical fistula persists, it may be closed

by one of the methods described in § 208, page 297. In injuries of the neck of the bladder and of the urethra it may prove necessary to perform a plastic operation on the latter.

§ 208. **Inflammatory Processes of the Bladder.**—Inflammation of the bladder (cystitis) is very common. It is either acute or chronic and involves either the mucous membrane or the whole thickness of the bladder wall. When confined to the vicinity of the bladder only it is called pericystitis.

Inflammation of the mucous membrane of the bladder is either catarrhal, croupous, or croupo-diphtheritic.

Acute catarrhal cystitis is due mainly to the entrance of pathogenic micro-organisms into the bladder. Retention of urine alone is not enough to cause an inflammation of the bladder. Thorkild, Rovsing, Barlow, Wreden, Krogus, and others have made a careful bacteriological study of the different forms of cystitis. It is the presence of micro-organisms that causes the cystitis following injuries, the entrance of foreign bodies, the formation of urinary calculi, the introduction of a non-aseptic catheter, etc. In some cases it is caused by the irritation of chemical substances—for example, after taking cantharides and food that is in the process of fermentation. Diseases of the digestive tract, especially of the rectum, have an ætiological importance in the production of cystitis, as microbes may from here gain access to the bladder by way of the blood or lymph channels as the result of very superficial lesions of the intestinal mucous membrane. Microbes are undoubtedly the chief and most common factors in the causation of cystitis, and it is they that bring about the chief symptom—viz., alkaline fermentation of the urine. Gonococci alone are unable to decompose urea, and consequently a cystitis with alkaline or ammoniacal urine can not be caused by gonococci, even though they may be present in the urine; gonorrhœal cystitis is usually the result of a mixed infection, especially from pus cocci. According to Barlow, a cystitis due to gonococci alone does occur in very rare cases. In fact, the decomposition of urea is not always essential in the production of cystitis. All instruments that are introduced into the bladder must be very carefully sterilized.

The anatomical changes in an acute catarrhal cystitis consist mainly of congestion, softening and swelling of the mucous membrane. The latter often contains small extravasations of blood. In every case of cystitis a careful chemical, microscopic, and bacteriological examination of the urine should be made, as one can in this way alone gain a clear idea of the variety of inflammation that is present. The urine is cloudy in consequence of an admixture of mucus and pus, its reaction is

slightly acid, or in well-marked cases, especially of chronic purulent cystitis, alkaline. On microscopic examination of the urine, one finds numerous red blood-corpuscles, and especially pus cells, desquamated epithelium, and many micro-organisms, particularly pus cocci and bacilli, depending on the nature of the inflammation. Krogius, Wreden, and others found the bacillus non-liquefaciens, the bacillus liquefaciens, the bacterium coli, the proteus vulgaris, the gonococcus, and various varieties of cocci, especially pus cocci (streptococci, staphylococci, diplococci), etc.

The other symptoms of acute cystitis are : Painful desire to micturate, with frequent voidance of a small amount of urine ; pain in the region of the bladder, and sometimes retention of urine in consequence of swelling of the vesical mucous membrane at the neck of the bladder or from reflex spasm of the sphincter. There is usually a moderate amount of fever. Acute catarrhal cystitis usually ends in from five to fourteen days in recovery. The toxic forms have the shortest course. The cystitis due, for example, to the ingestion of cantharides generally disappears in twenty-four hours.

Chronic catarrhal cystitis usually leads to deeper structural changes in the mucous membrane and the entire bladder wall. In this form also the mucous membrane is congested, swollen, the seat of hæmorrhages, and covered with a thick muco-purulent secretion. Polypous proliferations of the mucous membrane are often present. The desquamation of the bladder epithelium is more marked, often resulting in some places in the formation of large, deep ulcers. The submucosa is thickened and the muscular layer hypertrophied. The urine, which is very cloudy and gives an alkaline reaction, has a more or less offensive odour and contains a large amount of mucus, pus, desquamated epithelium, microbes in great numbers (cocci, bacilli), besides crystals of triple phosphate, calcium carbonate, and other alkaline sediments (see Pathology of the Urine, page 263). The other symptoms of chronic catarrhal cystitis are essentially the same as those of acute catarrh. The disturbances are at times slight and then again more severe, as exacerbations frequently occur. The duration of chronic cystitis is very variable, and it frequently extends over several years. In a severe chronic purulent cystitis complete recovery is rare and the process frequently extends to the ureters and pelvis of the kidney. (see page 235). Not infrequently one observes cases which have lasted for years, and yet the anatomical changes are very slight.

Some forms of cystitis are characterized by continuous pain (cystitis dolorosa) which can not be relieved by the usual remedies. These are usually cases of gonorrhœal, tubercular, and calculous cystitis.

The prognosis of chronic cystitis depends mainly upon the cause and degree of the inflammation.

The diagnosis of acute and chronic cystitis is made from the above-described symptoms and from the chemical, microscopic, and bacteriological examination of the urine.

Treatment of Acute and Chronic Cystitis.—The chief indication is to remove the cause of the inflammation—viz., the microbes that have entered the bladder. For this purpose it is advisable to wash out the bladder with the aid of a catheter and irrigator. The solutions used should be lukewarm—i. e., have a temperature of 98° to 100° F. Colder solutions (60° to 68° F.) are only advisable in case of atony of the bladder, when they aid in stimulating the contractility of its walls. Irrigation of the bladder is performed from one to three times a day with the aid of a sterilized metallic or soft catheter. A short rubber tube is fastened on to the end of the metallic catheter in order that the tip of the irrigator or syringe may be inserted air-tight. I consider the use of double-current catheters inadvisable, because it is better for the fluid that flows into the bladder not to run out again immediately, but to fill the same to a certain extent in order that it may come in contact with the whole surface of the bladder. Of late I have irrigated the bladder without the use of a catheter, as recommended by Rotter. A glass nozzle running out into a point is fastened into the end of the irrigating tube, and, having been wrapped around with sterile gauze covered with aseptic oil or ointment, is inserted one to two centimetres into the urethra. The tube is pressed circularly against the glans and the irrigator is elevated at first one metre and then two metres. In from one half to two minutes the fluid begins to flow into the bladder. Among the antiseptic solutions used for irrigating the bladder are: Three per cent boric acid, one half to two per cent carbolic acid, bichloride of mercury (1 to 5,000, 1 to 10,000, 1 to 20,000), aqua plumbi, two per cent resorcin, 0·3 to one per cent nitrate of silver, Rotter's solution (Rotterin), etc. Frey recommends the injection three times a day of an emulsion of iodoform (50·0 iodoform, 40·0 glycerin, 10·0 distilled water, 0·25 gum tragacanth). Okev-Blom speaks highly of a mixture of iodoform, ether, and oil (1 to 7 to 7). From one to six cubic centimetres of the solution are injected every two or three days by means of Guyon's instillator. Guyon and Colin recommend the instillation daily or every second day of from five to ten grammes of a strong solution of bichloride (1 to 500 or 1,000) into the bladder and from ten to fifteen drops into the region of the neck of the bladder and posterior urethra. Various individuals react very differently to bichloride of mercury; some can stand strong solutions (1 to 1,000 or

1 to 5,000), while in others they cause severe pain and hæmorrhage. Especially in painful chronic cystitis and gonorrhœal cystitis injections of one per cent nitrate of silver (fifty cubic centimetres, for example) or of cocaine or antipyrine (0·5 per cent to four per cent), followed by irrigation with 1-to-500 nitrate of silver, are very serviceable. Patients with cystitis should have a light diet and avoid alcohol. For the pain and distressing desire to micturate one may give hypodermic injections of morphine, cocaine, warm sitz baths, warm poultices about the abdomen, and narcotic suppositories in the rectum. The internal treatment of acute and chronic cystitis by means of drugs such as balsams (balsamum copaiabæ, peruvianum, oleum terebinthinæ), astringents (tannin, acetate of lead), or decoctum uvæ ursi, chlorate of potash, etc., is of little benefit. The administration of chlorate of potash and salicylic acid is the most effectual. Moreover, the old people's remedy, linseed tea, is sometimes useful. Sympson speaks highly of the administration of salol (salol, 8·0; pulv. acaciæ gummi, q. s.; aq. cinnamom., 360·0. Tablespoonful every four hours). Finally, the use of various mineral and spring waters are useful, especially Vichy, Carlsbad (Mühlbrunnen), Wildungen, Salvator-quelle, etc.

In my experience, the best treatment of acute and chronic cystitis consists in washing out the bladder with antiseptic solutions. One should begin the irrigations as soon as possible, and in any case if the inflammation has lasted more than a week. For the possibility of the passage of the fluid from the bladder into the ureters in irrigations of the bladder see page 235.

In case a cystitis has an underlying cause that demands operative interference, such as a vesical calculus, tumour, foreign body, etc., one must act accordingly, and, if necessary, open the bladder by perineal section, or, better, by suprapubic cystotomy. In the female, colpo-cystotomy is advisable in case dilatation of the urethra does not give sufficient access to the bladder. Suprapubic cystotomy in the male and colpocystotomy in the female are also to be recommended in cases of cystitis with continuous pain that resists all other forms of treatment. The bladder may, if necessary, be scraped out at the same time.

Diphtheritic and Gangrenous Inflammation of the Mucous Membrane of the Bladder.—Inflammation of the bladder sometimes takes on a diphtheritic character, especially when there is marked alkaline fermentation of the urine. Diphtheritic inflammation which is observed mainly in the fundus of the bladder is most commonly caused by infection with unclean instruments which carry in microbes with them. It also occurs in connection with diphtheria of the fauces and larynx, in the course of scarlet fever, and in other severe infectious diseases. The

diphtheritic process leads to more or less extensive necrosis of the epithelium and superficial portions of the mucous membrane—i. e., to gangrene with the formation of a gray or grayish-black pseudo-membrane which is not infrequently incrustated with urates. Healing takes place after the diphtheritic pseudo-membrane has been cast off, or the diphtheritic necrosis spreads further, involving fresh portions of the mucous membrane. The diphtheritic process is sometimes very extensive, and not infrequently involves the ureters and pelvis of the kidney. In its further course it often leads to perforation of the wall of the bladder, followed by a rapidly spreading fatal peritonitis or septic phlegmon of the extraperitoneal cellular tissue. In other cases it does not go on to perforation of the wall of the bladder, but gives rise to a suppurative infiltration of the submucous tissue (cystitis interstitialis purulenta, cystitis phlegmonosa). These interstitial abscesses of the bladder wall may rupture into the bladder, causing the evacuation of large amounts of pus with the urine and subsequent recovery. In other cases the abscesses rupture externally and lead to vesical fistulæ, suppurative peritonitis, or extraperitoneal phlegmonous pericystitis. One finds this phlegmonous cystitis and pericystitis most frequently after injuries and after extension of an inflammation from the vicinity. Pericystitic abscesses frequently rupture into the vagina, rectum, and perinæum, and give rise to the formation of fistulæ. As in other mucous membranes, one sometimes observes an erysipelas that originates in the mucous membrane of the bladder (Frisch).

The treatment of diphtheritic cystitis consists first of all in the use of the above-mentioned antiseptic irrigations. In severe diphtheritic inflammation the best means of keeping the bladder clean and preventing the inflammation from ascending to the kidney is by performing suprapubic cystotomy. Suppurative inflammation of the bladder wall and pericystitic abscesses are treated according to general principles—i. e., the abscess is opened, as soon as it can be made out, either through the perinæum, or, in case of a collection of pus in the prevesical space, above the symphysis or beneath the pubic arch (Langenbuch).

Hæmorrhoids of the Bladder.—By hæmorrhoids of the bladder is understood a dilatation of the vessels of the mucous membrane, especially near the neck of the bladder, in consequence of long-continued congestion of the bladder and pelvic organs. These hæmorrhoids sometimes give rise to difficulty in urination and severe hæmorrhages (hæmaturia). Should the latter occur, the bladder is to be carefully irrigated with antiseptic solutions (see page 294, Cystitis), in order that decomposition of the blood, cystitis, etc., may be prevented. Meisels recommends cornutin (0.01 a day) for hæmorrhage from the genito-urinary organs. It is supposed to cause a permanent contraction of the vessels and involuntary muscular fibres of these organs.

Tubercular Cystitis.—Tuberculosis of the bladder is usually secondary to primary tuberculosis of the lungs, or is a sequence of tuberculosis of the pelvis of the kidney and the genital organs. Primary tuberculosis of the bladder is rare. One frequently finds a tubercular cystitis following tuberculosis of the epididymis and the prostate. It frequently extends in such cases to both kidneys. It is rarer for tuberculosis of the bladder to result from the extension downward of tuberculosis of the kidneys. In the female, tubercular cystitis is very rare. Among 2,565 autopsies of females in the hospital at Dresden, Birch-Hirschfeld found tubercular disease of the bladder only four times.

Tubercular cystitis begins by the formation of the characteristic grayish-white nodules, which gradually increase in size, undergo caseous degeneration, and form ulcers with a cheesy base. Tubercular ulcers increase in size by the coalescence of single small ulcerations and the gradual destruction of the margins of the ulcers. One sometimes finds tubercular ulcers of such a size that a large part of the mucous and submucous layers is destroyed.

The diagnosis of tubercular disease of the bladder is best made by means of the cystoscope and by examination of the urine for the presence of tubercle bacilli.

The symptoms of tubercular cystitis are in the main those of a severe chronic cystitis. The pain is usually very severe (*cystitis dolorosa*, see page 293).

The prognosis is bad, as is true of tuberculosis of the genito-urinary organs in general. Death usually results in a short time from general tuberculosis or tuberculosis of the lungs or kidneys. In my experience, the most unfavourable form of tuberculosis of the genito-urinary organs is tubercular epididymitis and orchitis, which ends fatally in a comparatively short time from general tuberculosis or phthisis. It is particularly characteristic of primary tuberculosis of the genito-urinary system to attack one organ after the other, and one can here, as nowhere else, follow it from its point of origin to each succeeding organ that it involves.

The treatment of tubercular disease of the bladder is symptomatic. A radical mode of treatment is usually impossible, as other tubercular lesions coexist. In case the disease is confined to the bladder, injections of idoform are to be recommended, and, above all, operative treatment, consisting, for example, in suprapubic cystotomy and scraping out or excising the tubercular area.

Syphilis of the Bladder.—Among other ulcers of the bladder, mention should be made of the very rare ulcers occurring in the later stages of syphilis.

Rokitansky described a simple perforating ulcer of the bladder which is analogous to the round ulcer of the stomach. It is usually situated on the posterior wall of the bladder and sometimes leads to perforation. The ætiology and nature of this ulcer of the bladder are still but little understood.

Vesical Fistulæ.—We shall consider here only the vesical fistulæ occurring in the male, those in the female being described in the surgery of the female genito-urinary organs. Vesical fistulæ occur most frequently in the male as the result of injuries and inflammations of

the bladder and its vicinity, with perforation, and of destructive tumours, especially carcinoma. Fistulæ of this sort open in the hypogastric region, the perinæum, or into the rectum or other portions of the intestine. It is characteristic of vesical fistulæ that urine in variable quantities escapes through the fistulous opening. If there is a communication between the intestine and bladder, fæces and gas may enter the bladder and be evacuated with the urine. At the outset the urine is mixed with gas only, which can be ascertained by letting the patient urinate while in the sitz bath. It is rarer for the urine to pass into the intestine. Absorption of decomposed urine within the intestine has been known to cause death from uræmia. Cripps collected sixty-three cases of vesico-intestinal fistula, and found that they were caused most frequently by injuries, malignant tumours, and inflammatory processes. The prognosis of recto-vesical fistulæ is unfavourable, and the patients often have a great deal of pain. The urine in recto-vesical fistulæ is often held back by the sphincter ani. Vesical fistulæ are sometimes canal-shaped, sometimes lipped—i. e., the mucous membrane of the bladder has grown together at the mouth of the fistula with the skin or the rectal mucous membrane. The prognosis of vesical fistulæ depends in general upon their location and whether they are accessible to operative treatment or not.

The treatment of vesical fistulæ consists in mild cases in repeated cauterization with the nitrate-of-silver stick, the thermo-cautery or galvano-cautery, and, best of all, in freshening and suturing the same. The best method in the male is to make the fistula accessible by performing suprapubic cystotomy, and then to freshen and suture its edges. In some cases a vesico-intestinal fistula may be healed by scraping it out carefully and then keeping the bladder irrigated. Vesico-rectal fistulæ may be made accessible by dividing the sphincter ani along the posterior rhapshe or the rectum after resection of the coccyx or sacrum by the method of Kraske or Bardenheuer (see § 180, page 172). In vesico-intestinal fistulæ, especially where the small intestine is involved, laparotomy may be indicated. In suitable cases the fistula may be closed from within the bladder after performing suprapubic cystotomy. In case of fistulæ of the large intestine where it is impossible to close the fistula by operative measures, Bryant recommends left lumbar colostomy, because, as statistics show, fistulæ of the large intestine are always situated below the descending colon. It is of great importance in every form of treatment, whether operative or not, that the patient be kept in such a position that no urine flows through the fistula. Patients with a fistula of the posterior wall of the bladder and of the perinæum should accordingly lie upon

their abdomen. The use of a permanent catheter is also serviceable by keeping the bladder empty. The cystitis which is usually present should be treated by antiseptic irrigations of the bladder (see page 294).

The technique in freshening vesical fistulæ is essentially the same as in the female, which will be taken up in detail in the surgery of the female generative organs.

Hypertrophy and Atrophy of the Bladder Wall, particularly the Muscular Coat.—Hypertrophy of the wall of the bladder occurs in inflammatory processes, such as chronic cystitis, in stone, and all those conditions which interfere with the evacuation of the urine—for example, hypertrophy of the prostate and strictures of the urethra. In all such cases of hindrance to the passage of urine frequent and energetic contractions of the bladder take place in order to overcome these obstacles. This results in hypertrophy of the muscular coat. This hypertrophy is accompanied by dilatation of the bladder (eccentric hypertrophy), or by diminution in its size (concentric hypertrophy). The inner surface of the hypertrophied bladder is often thrown into folds, or there may be pouches and diverticula. The muscular bundles project in the form of interlacing trabeculæ. The mouths of the ureters and the internal orifice of the urethra may in this way be more or less narrowed or occluded, so that the ureters and pelves of the kidney become dilated or retention of urine takes place. The hypertrophied muscular coat sometimes undergoes a colloid degeneration. In such cases the walls of the dilated bladder are rigid, the muscular coat is firm and inflexible, and the bladder can contract only imperfectly (India rubber bladder). In other cases there is more or less fatty degeneration of the hypertrophied muscular coat and the bladder wall is remarkably weak, so that perforation may occur from slight contractions or the introduction of a stone-searcher.

The treatment of hypertrophy of the bladder should be directed first of all against the underlying cause, such as cystitis, calculi, strictures, etc. The regular evacuation of the bladder is secured by the passage of a catheter, irrigation, electricity, etc. If the bladder is diminished in size and there is a frequent desire to micturate it is sometimes a good plan to dilate the bladder by the injection of lukewarm fluid and allow the latter to remain in the bladder for some time.

Atrophy of the bladder occurs in many cases of chronic cystitis, anæmia, marasmus, etc. The atrophy usually involves all the coats of the bladder. The mucous coat is very thin and the muscular layer is partially or wholly absent.

Inflammatory Processes in the Prevesical Space of Retzius.—Inflammations of the cellular tissue in general in the vicinity of the bladder may be the result of traumatism, diseases of the bladder and other pelvic organs, or metastasis. In addition, there are idiopathic inflammations of the space of Retzius without a lesion of the bladder, the ætiology of which is often obscure. Englisch collected thirty cases of this latter variety of inflammation. In some cases the inflammation appears to develop as the result of disorders of the intestines, or at least the intestinal symptoms are very prominent

(constipation, diarrhœa, severe gastritis, and enteritis). In a further category of cases the inciters of inflammation come from the peritoneal cavity, especially in case of tuberculosis. Inflammations of the space of Retzius are characterized by a sharply localized swelling which resembles at first sight a distended bladder. The introduction of a catheter will make the condition evident. The inflammation may spread within the perivesical cellular tissue in the pelvis as far as the thigh, and not infrequently the bladder is attacked secondarily. Suppuration does not always follow. The abscess, if not incised, perforates usually into the adjacent cavities (peritoneal cavity, bladder, large intestine, urethra, vagina).

The treatment of all inflammations of the space of Retzius consists in a prompt incision, preferably a transverse one, just above the symphysis, as in performing suprapubic cystotomy.

Hygroma of the Space of Retzius.—Guyon called attention to a collection of serous fluid in the prevesical space which he explains as a hygroma. The wall consists only of connective tissue without epithelium, which differentiates them from the urachal cysts which occur in this vicinity. They may resemble also a distended bladder. Examination with a catheter and *per rectum*, external palpation, etc., will usually clear up the diagnosis. Suppuration of a hygroma may give rise to a prevesical phlegmon.

The treatment consists in incision and drainage. Complete extirpation is usually difficult, owing to adhesions with the peritonæum.

§ 209. **Neuroses of the Bladder.**—Among the neuroses of the bladder those that interest us most are spasm, neuralgia, paralyses, and enuresis nocturna.

1. *Spasm of the Bladder (Irritable Bladder).*—In this condition there is an abnormal irritability of the bladder accompanied by frequent contractions of the same from even the slightest causes. The presence of a small quantity of urine in the bladder is often sufficient to cause severe pain with a cramplike contraction of the detrusor or sphincter muscles. In the latter case the vesical end of the urethra is closed, while in spasm of the detrusor muscle the urine is voided with great pain. Spasm of the sphincter muscle occurs most frequently during the introduction of a catheter. In marked cases of vesical spasm the attacks are repeated at more or less regular intervals as soon as a certain amount of urine has collected in the bladder. Irritable bladder is sometimes accompanied by other nervous phenomena mainly of a reflex nature, such as vomiting, cold sweats, feeling of anxiety, syncope, and even general clonic spasms. In neuroses of the bladder, pure and simple, neither the bladder nor the urine are changed pathologically, and hence this purely nervous spasm of the bladder is to be differentiated from the conditions of irritation occurring in connection with inflammatory changes. Neuroses of the bladder sometimes run a very chronic course, lasting for years. Finally they take on a milder character, and the only symptom noticeable is that the patient has to

urinate more frequently than normal; for instance, every two or three hours, with or without cramplike pains.

As regards the ætiology of spasm of the bladder, it is found most frequently in neurasthenic individuals as the result, for example, of mental agitation, after taking cold, in masturbators, in persons with hæmorrhoids, in beginning disease of the spinal cord, etc. I saw two very typical cases that lasted for several years in two business men, who, during a protracted railroad journey, had been unable to pass their urine for a very long time.

The prognosis of spasm of the bladder depends in the main upon the cause of the same, but is usually favourable. Its duration is seldom more than a year, and complete recovery generally takes place.

It is characteristic for the diagnosis of vesical spasm that the urine is normal and that there is no disease of the bladder.

The treatment of spasm of the bladder is directed, above all, against the cause, such as neurasthenia. The attacks of spasm should be treated, as a rule, by warm baths, opium enemata, morphine hypodermically, and both kinds of electricity. The bladder should be evacuated regularly by means of a catheter and irrigated with lukewarm antiseptic solutions (see page 294).

2. *Neuralgia of the Bladder (Cystalgia)*.—Cystalgia is not a disease *sui generis*, but merely a symptom which comes into prominence in different diseases of the bladder, the adjacent organs, and the nervous system, and in various constitutional affections. The prognosis and treatment are determined, therefore, by the underlying disease. In all cases where the pain is not lessened by medical treatment, local or general, operative measures are indicated, consisting in the male usually in suprapubic cystotomy and in the female in colpocystotomy. The after-treatment depends, then, upon what is found in the interior of the bladder. For a description of cystitis dolorosa, see page 293.

3. *Paralysis of the Bladder*.—Among the paralyses of the bladder we shall mention first the complete or incomplete paralysis of the detrusor-urinæ muscle, which normally expels the urine, with atony of the bladder, and frequently with retention. It is most frequent in elderly individuals, but it may occur in children. The causes of this paralysis of the detrusor muscle are to be sought for both in disturbances of innervation, due to cerebral and spinal diseases, and in a weak condition of the bladder in consequence of the various diseases of the bladder and its neck. Holding the urine for too long a time and too frequently with a full bladder is an important factor, as the detrusor muscle is thereby stretched and relaxed. In such cases the sensibility of the bladder is diminished, so that the patient does not feel the desire

to urinate as under normal conditions. In the same way the habit that many persons have of not emptying the bladder completely has a tendency to relax the detrusor muscle. One of the commonest causes of this functional disturbance of the detrusor muscle depends upon a mechanical hindrance to urination, especially from hypertrophy of the prostate and stricture of the urethra. The relaxation of the muscle is here a result of its frequent overexertion in overcoming the obstacle to the evacuation of urine. In all cases where there is complete paralysis of the detrusor muscle the bladder becomes more and more distended in consequence of the gradually increasing collection of urine, until the resistance of the sphincter vesicæ, if it be intact, is overcome and the bladder simply runs over. The urine dribbles out in a purely mechanical way while the retention remains the same, the bladder continuing to be full. Urine continues to flow only until the pressure within the bladder is less than the power of contraction of the sphincter muscle. This condition is called the incontinence of retention. Many patients of this sort do not know even that they are suffering from retention of urine. If not recognised, this incontinence of retention may cause death from uræmia very quickly, especially in weakened individuals. If the urine is drawn off with a catheter, one often notices in the next few days a decided increase in the amount of urine secreted (polyuria).

Retention of urine, though sometimes due to paralysis of the detrusor muscle, is much more frequently the result of injuries and diseases of the urethra, particularly strictures, of enlargement of the prostate, of tumours of the neck of the bladder and in the vicinity of the urethra, etc. (see Surgery of the Prostate and Urethra). If it continues for a long time, retention of urine may give rise to general dropsy in consequence of the mechanical obstruction to the flow of urine from the kidneys.

The diagnosis of retention of urine is easy, as one can make out the distended bladder above the symphysis by palpation and percussion. The simplest way to make sure of the diagnosis is to introduce a catheter into the bladder. It is of importance that chronic retention of urine (chronic uræmia) due to various diseases of the urinary organs and prostate often gives rise to digestive disturbances.

To treat retention of urine successfully it is of chief importance to discover its cause. We shall consider here only those cases that are due to nervous disturbances. In such cases the bladder should be emptied regularly in order to relax the stretched detrusor muscle. Complete evacuation of the bladder is best accomplished with the patient standing up. By way of prophylaxis one should advise elderly

individuals to urinate standing up and at certain intervals. In suitable cases of atony of the bladder one may make use of electricity and cool antiseptic irrigations. In the application of electricity one electrode is placed against the hypogastrium above the symphysis and pressed in as deeply as possible, and the other against the perinæum or in the rectum, as high up as possible. One can also introduce catheter-shaped metallic electrodes into the bladder, which, with the exception of their tip, are covered with India rubber. In incurable paralysis of the detrusor muscle resulting, for example, from disease or injury of the spinal cord, where there is incontinence of retention with dilatation of the bladder and continuous dribbling of urine, one may place a urinal between the legs of the patient and allow the urine to flow out without the aid of a catheter. If it is desirable to insert a permanent catheter into the bladder, one should make use of a carefully sterilized soft-rubber catheter which is introduced as far as the neck of the bladder and fastened to the penis with a silk thread, adhesive plaster, or in the way shown in Figs. 525 and 526, page 278. The general condition of the patient should be carefully considered. In atony of the bladder — i. e., imperfect contractility of the detrusor muscle — bog baths are often of great service. Quinine and iron in the form of carbonized chalybeate water are given internally. For this purpose a course of treatment at Schwalbach, Franzensbad, or Marienbad (Ferdinandsbrunnen) is recommended.

In all cases where the bladder can not be evacuated by the introduction of a catheter one will have to overcome the retention by puncture of the bladder (see § 210, page 304), or, if there is an impassable stricture of the urethra, by external urethrotomy (§ 223).

4. *Paralysis of the Sphincter Muscle (Incontinence of Urine).*—In paralysis of the sphincter vesicæ the patient is unable to hold his urine, and it therefore escapes involuntarily.

In this category may be mentioned that form of incomplete paralysis of the sphincter that exists only at night, and which is known as enuresis nocturna. Individuals of this sort, usually children, are unable to retain their urine while asleep, although they can do so perfectly well when awake and during the day. One sometimes finds cases, however, where during the day as well there are irregularities in urination. The ætiology of this enuresis nocturna is still obscure, but we probably have to do with reflex processes. The children who suffer from this affection are usually weak, nervous, and irritable children, and they often urinate as the result of dreams. Enuresis has often been known to result from digestive disturbances, affections of the naso-pharynx, respiratory difficulties, etc., and to disappear after cure

of these abnormalities. It also disappears, as a rule, at the time of puberty.

There are, moreover, individuals who are unable to hold their urine completely when standing and walking or when they cough or sneeze. In such cases there is usually incomplete closure of the sphincter in consequence of senile atrophy of the same.

The incontinence of retention is another form of incontinence which we have already described on page 302. We saw that the intravesical pressure of the urine when increased up to a certain point overcomes the action of the sphincter.

Finally, incontinence of urine may result from complete paralysis of the sphincter, due, for example, to disturbances of the central nervous system, injuries of the sphincter, dilatation of the same from cicatricial distortion, hypertrophy of the prostate, etc. These pathological conditions will be taken up in detail under diseases of the urethra and prostate.

The treatment of incontinence varies with its cause. In enuresis a careful examination is to be made of the entire body for the presence of any reflex cause, such as affections of the naso-pharynx, digestive disturbances, etc., and the same should be treated. The diet should, moreover, be regulated, the children being given dry food at night and nothing to drink. A general strengthening regimen is very useful, especially bathing in cold water, and, moreover, the application of electricity in the way described on page 303. The favourite internal remedies are ergot, ergotin, strychnine, and especially atropine. In obstinate cases, cauterization of the neck of the bladder by the use of Lallemand's applicator (see page 357, Fig. 565) has been well spoken of, and dilatation of the urethra and neck of the bladder with special dilators, such as Oberländer's. One should be very cautious in the use of both these methods. The results of dilatation of the urethra and sphincter muscle have proved, however, to be excellent in the treatment of enuresis.

In the other cases of complete or incomplete incontinence of urine the treatment depends, as already said, upon the cause. In suitable cases the patient is made to wear a rubber urinal, which surrounds the penis and is secured to the pelvis and thigh by means of a strap.

§ 210. **Puncture of the Bladder for Retention of Urine.**—In all cases of retention of urine, where catheterization is impossible, evacuation of the bladder by operative means is indicated either by puncture, suprapubic cystotomy, or external urethrotomy. Puncture of the bladder is performed most frequently for retention due to hypertrophy and tumours of the prostate and in exceptional cases for injuries and im-

passable strictures of the urethra when, for any reason, an immediate external urethrotomy is impossible. At the present time puncture of the bladder is nearly always performed above the symphysis. The other methods—viz., puncture through the perinæum, below the pubic arch, through the rectum, or through the vagina—have been almost completely abandoned.

The technique of puncture above the symphysis is as follows: The patient is placed in the horizontal position and one determines by palpation and percussion the degree of distention of the bladder, whereupon the lower portion of the abdomen above the symphysis is shaved, scrubbed, and disinfected with 1-to-1,000 bichloride. One then makes under cocaine or ether spray a small incision in the skin with the point of a knife just above the symphysis in the linea alba. As a guide one should place the tip of the left index finger at the centre of the upper border of the symphysis. This preliminary incision is to be recommended because the elastic skin easily slips to one side before the point

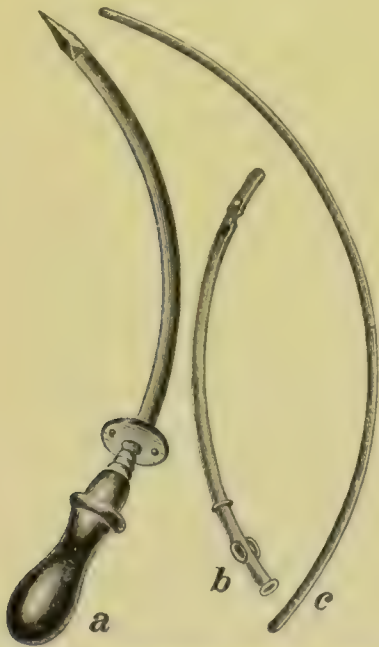


FIG. 531.—*a*, Trocar for suprapubic puncture of the bladder; *b*, canula; *c*, director.

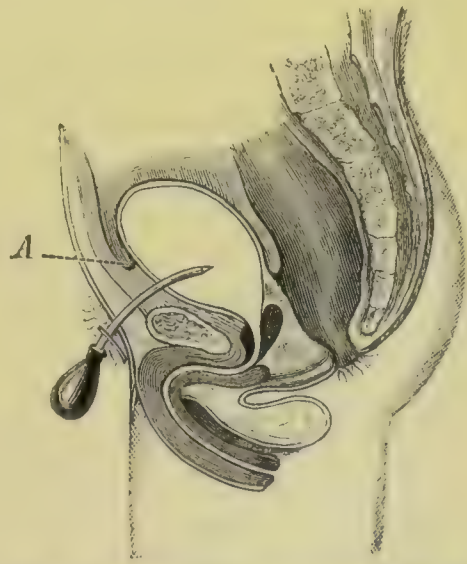


FIG. 532.—Suprapubic puncture of the bladder (diagrammatic): *A*, reflection of the peritonæum.

of the trocar. The tip of an aseptic trocar (Fig. 531, *a*) is now inserted within the small cutaneous incision and pushed through the abdominal wall into the bladder in such a way that its point is directed downward (Fig. 532). Injury to the peritonæum is impossible, which is evident from Fig. 532, as the anterior extraperitoneal surface of the distended bladder extends for some distance above the symphysis and there is sufficient space between the latter and the reflection of the peritonæum (Fig. 532, *A*). The entrance of the point of the trocar into the bladder is distinctly perceived by the diminished resistance.

The trocar should not, of course, be pushed too far into the bladder. If the stylet is now withdrawn from the trocar, the urine flows out through the canula usually with considerable force and in large amounts. The canula is pushed farther into the bladder and a second (inner) canula (Fig. 531, *b*) is inserted into the outer one, which can be removed from time to time for the purposes of cleaning and disinfecting the same. The outer canula is secured by a band and strings carried around the abdomen, which are drawn through the holes in the metallic shield. The permanent escape of urine is brought about in the best way by means of a long rubber tube which is fastened to the outer end of the projecting inner canula and connected with a bottle placed between the legs of the recumbent patient or outside the bed and partially filled with 1-to-1,000 bichloride or three-per-cent carbolic. The outer canula as well should after a few days be removed from time to time in order that it may be cleansed and freed from urinary deposits that have been precipitated upon it. This is best accomplished by introducing a long director (Fig. 531, *c*) through the canula into the bladder and withdrawing the outer canula over this. The director is left in the bladder until the outer canula has been replaced.

The canula remains in the bladder for a longer or shorter time, depending on the case, but at all events until the urine can be evacuated spontaneously or by means of a catheter. In place of the metallic double canula one may insert at the end of a week a soft-rubber catheter, which is secured by two safety pins stuck through its sides, and fastened with adhesive plaster to the abdomen. The soft-rubber catheter is closed with a clamp or wooden plug, and the patient can then leave his bed.

If the natural urinary passages remain permanently impassable, the only thing left to do in some cases is to allow the fistula above the symphysis to remain open. Such patients are not obliged to wear a soft-rubber catheter, but, on the contrary, the latter is removed after a time, and the urinary fistula remains closed by contraction of the recti muscles. For the purpose of evacuating the urine the patient passes a soft-rubber or metallic catheter through the fistula into the bladder. Patients of this sort can sometimes pass their urine spontaneously through this substitute for the urethra above the symphysis. The condition of such patients is, in my experience, not so pitiable as sometimes represented.

Posterior Catheterization.—Brainard was the first to use the puncture opening, after puncture of the bladder, for the purpose of catheterizing the urethra from within the bladder and dilating strictures. The director shown in Fig. 531 *c* may be used for this purpose. It is introduced through the fis-

tula into the bladder until it catches in the internal orifice of the urethra. The patient lies on his back, the pelvis is elevated by a cushion placed underneath, and the thighs are flexed for the purpose of relaxing the abdominal wall. Bergmann recommends the introduction of the rectal bag for the purpose of elevating the posterior wall of the bladder (see Figs. 540-542, pages 318, 319). In order to pass the sound from the internal urethral orifice into the urethra, one must depress the abdominal wall as much as possible by pressure with the hand. In a similar way suprapubic cystotomy has been performed for rupture of the urethra and a soft catheter introduced through the bladder in order to find the proximal end of the divided urethra.

§ 211. **Foreign Bodies in the Bladder.**—The most varied kinds of foreign bodies are found in the bladder, into which they usually enter through the urethra. They include broken-off portions of catheters, hairpins, lead pencils, straws, etc. As the female urethra is short and wide, and runs in a straight line, it is not uncommon for foreign bodies to enter the bladder through the urethra. In other cases we have to deal with penetrating wounds of the bladder; for example, gunshot wounds where the ball has entered the same. In fractures of the pelvis it is not uncommon for splinters of bone to enter the bladder.

The most important foreign bodies in the bladder are vesical calculi, which we shall take up in detail in § 212.

Among animal parasites in the bladder mention should be made of the echinococcus, as well as the eggs and embryos of *Filaria sanguinis* and of *Distoma hæmatobium*, which reach the bladder from the kidneys by way of the ureters. Among vegetable parasites the most varied species of microbes may be found in the bladder, some of which enter it by way of the kidneys and urethra, others through penetrating wounds in the bladder or through the circulation. I mention principally tubercle bacilli, anthrax bacilli, pus cocci, etc., which are evacuated with the urine. Cocci and sarcinæ are the most common forms of micro-organisms found in the bladder. Yeast fungi occur especially in diabetic urine, in which they cause alcoholic fermentation with the development of carbonic acid.

The symptoms of a foreign body in the bladder depend mainly upon the nature and shape of the same. The above-mentioned animal and vegetable parasites cause manifestations depending on their nature. Larger foreign bodies cause in general the same symptoms as stone, especially pain and irritation. It is important to remember that pointed foreign bodies especially may perforate the wall of the bladder, wander about, and come to view at another part of the body. As we shall see under the subject of vesical calculi, foreign bodies favour the formation of stones, inasmuch as urinary sediments, especially uric acid, urates, and phosphates, are deposited about the foreign body as a nucleus.

The diagnosis of a foreign body in the bladder is easier in the female than in the male, as in the former one can, after dilatation of the urethra, palpate the whole bladder with the finger (see § 253, *Surgery of the Female Urinary and Generative Organs*). In the male the diagnosis of a foreign body is made possible mainly by the introduction of a stone-searcher (see Figs. 535 and 536, page 313) and by cystoscopy (page 280).

Treatment of Foreign Bodies in the Bladder.—Every foreign body in the bladder should be removed from the same as promptly as possible, and, generally speaking, in the same way as a vesical calculus. All pointed foreign bodies which are too large to be extracted through the urethra should be removed by operative means, preferably by suprapubic cystotomy. Suitable foreign bodies may be broken up with the lithotrite (see Fig. 537, page 315), and then removed through the urethra. For a description of the technique of suprapubic cystotomy and lithotrity, see §§ 213 and 214. Harrison recommends in suitable cases the use of an evacuating catheter with an aspirating bottle, as in litholapaxy (see page 317, Figs. 538 and 539). Only the smaller foreign bodies and those that are long and narrow can be extracted through the urethra by means of suitable forceps. Collin's "redresseur" is particularly suited to the extraction of long foreign bodies. It is a sort of lithotrite which seizes the object and turns it into a longitudinal direction so that it can be extracted.

Foreign bodies can be easily removed from the female bladder by dilatation of the same by Simon's method (see *Surgery of the Female Bladder*).

§ 212. **Vesical Calculi.**—Vesical calculi may be formed primarily in the pelvis of the kidney and then go on enlarging within the bladder, or they may develop primarily in the latter. The causes of stone formation are very varied. A foreign body frequently gives rise to a stone, inasmuch as urinary sediments form about it as a nucleus, and it becomes, as it were, incrustated. In the same way parasites and blood clots favour the formation of stone. Calculi frequently owe their origin to a cystitis, especially where there is ammoniacal fermentation and an abundant sediment. The stones that originate in the pelvis of the kidney are often a result of the uric-acid diathesis, and are found in persons with gout. The development of vesical calculi is also favoured by cardiac affections, especially degeneration of the heart muscle and circulatory disturbances in general with a coexisting uric-acid diathesis. Certain localities offer conditions that are particularly favourable to the development of stone. Thus the drinking water and wine of some places have been thought to be responsible. Drinking water that

contains a large percentage of calcium and magnesium salts is said to be particularly favourable to the formation of stones. In England both gout and stone are very common, and this is explained by the fact that Englishmen eat large amounts of meat which is rich in nitrogen. Stones originating in the kidney either remain in the pelvis of the kidney or the ureter, or they descend into the bladder and enlarge here gradually in case they do not pass out through the urethra. Multiple stones are found most commonly in case of hypertrophy of the prostate because in consequence of the latter the fundus of the bladder comes to form a pouch in which small stones

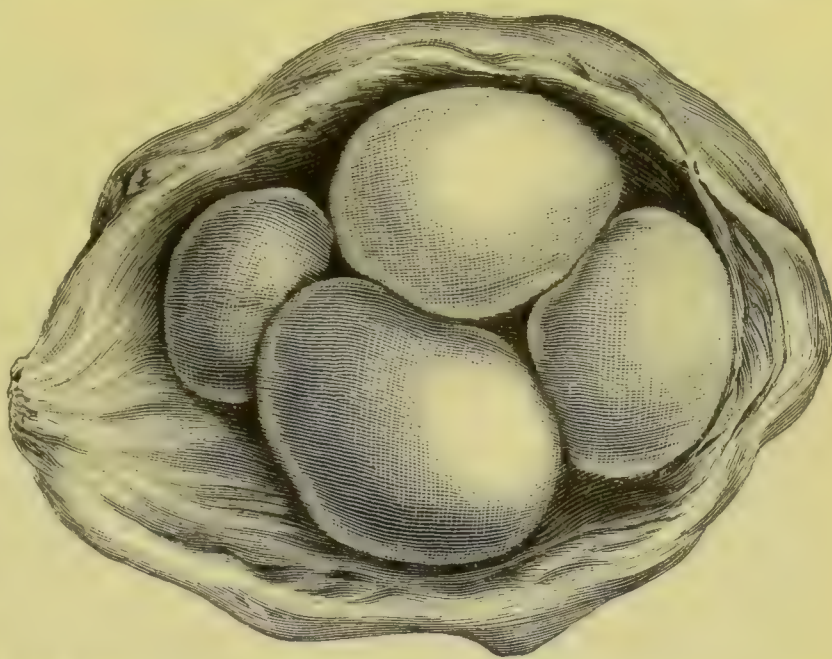


FIG. 533.—Four phosphatic calculi found in the bladder of a man sixty-five years of age who died of apoplexy.

from the kidney may be easily retained. The uric-acid diathesis is a constitutional condition which is brought about mainly by the mode of life—especially too much nitrogenous food and a sedentary employment. Muscular over-exertion may also cause the excretion of too much uric acid and urates. Stone is much more common in the male than in the female. Thompson operated on eight hundred and fifty-seven men and only thirty women and children. Among others, Güterbock has recently given an exhaustive account of stone of the bladder.

Ebstein and Nicolaier caused stone in dogs and rabbits by feeding them with pure oxamide, an ammonium derivative of oxalic acid. The largest stones were found in the pelvis of the kidney, and the smallest in the form of sand or gravel in all portions of the urinary tract. The concretions were composed of oxamide with an albuminous framework.

With reference to their chemical composition the following varieties of stone may be distinguished :

1. Calculi which are composed mainly of uric acid and urates. Pure uric-acid stones are usually small, hard, yellowish, reddish, or mahogany-brown. In cross-section they are, as a rule, smooth and formed of concentric

layers. Uric-acid stones do not usually originate in the bladder from local causes, but generally in the pelvis of the kidney in consequence of the uric-acid diathesis. In this there is an increased formation of uric acid owing either to insufficient oxidation of the nitrogenous substances, as in diseases of the heart and lungs when the supply of oxygen is diminished or to an excess of nitrogenous food or a sedentary life. If in such cases of increased formation of uric acid there are not sufficient alkalies present to keep the uric acid in solution, then the latter is deposited in the form of a precipitate. Under ordinary circumstances urine that has stood for some time and grown cold contains a reddish precipitate of uric acid and urates, especially acid-sodium urate. Gravel is composed mainly of uric acid and urates. The stones made up of urates consist of sodium urate, ammonium urate, and magnesium urate, and their surface is often covered with deposits of oxalate of lime and ammonio-magnesium phosphate. The stones that consist mostly of ammonium urate are usually small, spherical, flattened, and clay-coloured, while those made up of magnesium urate are ash-gray in colour. The surface of the stones usually has small projections, especially if they have a covering of oxalic acid. Ammonium urate crystallizes in a spherical or roseate form (Fig. 512, page 263), and is particularly likely to be present in alkaline urine. Alkaline fermentation due to suppurative cystitis or the presence of microbes gives rise, therefore, to the stones made up of ammonium urate and magnesium urate.

2. Phosphatic stones made up of the phosphate of lime and the phosphate of ammonium and magnesium (triple phosphates) are also formed from alkaline fermentation. The phosphates are in solution in normal urine, but are precipitated as soon as the urine becomes alkaline—for example, from the presence of microbes. Phosphatic stones are of a grayish-white colour, and the more triple phosphates they contain, the looser and more earthy their structure. Phosphatic stones, especially those made up of the triple phosphates, may reach a considerable size. For a description of the crystal forms of the triple phosphates see Fig. 515, page 263.

3. Stones composed of pure carbonate of lime are rare and of a characteristic chalky-white colour.

4. Stones made up of the oxalate of lime are very hard, have a brown colour, and are characterized by a spinous surface, for which reason they are sometimes called mulberry stones. They are not uncommon, and sometimes reach a very large size. These stones either consist almost exclusively of the oxalate of lime, or they have an admixture of urates or phosphates. Their origin is in general the same as those made up of urates, as the oxalate of lime is also precipitated by acid fermentation. For a description of the crystal forms of the oxalate of lime see Fig. 513, page 263.

5. Cystin stones are rare. They are ovoid, soft, waxlike, brownish-yellow, and have a shining crystalline surface when broken. They sometimes have a covering of phosphates or uric acid. Cystin crystals are represented in Fig. 514.

6. Xanthin stones are very rare. They are cinnabar-red, smooth, and have an earthy surface when broken.

Ord and Forbes found an indigo stone in the kidney.

In the majority of cases vesical stones are made up of various constituents. The nucleus consists most frequently of uric acid or urates and oxa-

lates which are often deposited about a foreign body. Urinary calculi often show a number of layers on cross-section, and the separate layers have a different chemical composition, depending on the acid or alkaline reaction of the urine at the time. We know that different substances are precipitated, depending on the reaction of the urine: if it is acid uric acid, sodium urate and oxalate of lime are deposited; and if alkaline, the phosphates and ammonium urate.

Besides the inorganic constituents, vesical calculi also contain organic substances, especially epithelial cells, red blood-cells, pigment, etc., and this combination of organic with inorganic materials plays an important part in the origin and growth of the calculi. In animals masses of spermatozoa have been found to form the nucleus of a stone (Birch-Hirschfeld).

Stones formed from urates are the most common, then the phosphates and the oxalates.

The size of vesical calculi varies from gravel or concretions the size of a pea to stones as large as a hen's egg and larger. Stones weighing from two thousand to twenty-five hundred grammes have been reported. Very frequently several stones are found in the bladder, and their number may even reach the hundreds. If there are several stones in the bladder, their surfaces are usually faceted (see Fig. 533, page 309). Birch-Hirschfeld found in the cadaver of a man fifty-two years old, who since his twenty-first year had suffered from cystitis following gonorrhœa, no less than a hundred and twenty phosphatic stones varying in size from a grape seed to a pigeon's egg.

Symptoms and Course of Vesical Calculus.—As long as a stone of the bladder is small there are no special symptoms excepting those of a cystitis and the previous attacks of renal colic due to the presence of a stone in the kidney (see § 197, page 249). As the stone grows larger the patient complains of painful and difficult urination. The stone may come to lie over the internal orifice of the urethra, and in this way interfere with the escape of urine. If the patient assumes a horizontal position or bends well over, urination is easier, because in these positions the stone can not cover the internal orifice of the urethra. In consequence of the difficulty in urination, the bladder wall, especially the muscular coat, becomes hypertrophied after the disease has lasted for some time. In children prolapse of the rectum occurs not infrequently as the result of pressing.

Pain may be entirely absent, however, even in the case of large stones when there is no cystitis. In other cases patients complain of severe pain after the bladder has been emptied, owing to the bladder contracting upon the stone. Pointed stones composed of oxalate of lime are particularly likely to cause pain at the end of urination. The pain is not confined to the region of the bladder, but is felt in the urethra and the end of the penis. Pain upon defecation occurs, particularly in the case of large stones. The urine often contains blood, and,

when there is a chronic cystitis, mucus and pus as well. Its reaction may then be alkaline. Stones sometimes lie in a diverticulum of the bladder and may become more or less completely encapsulated. Wut-

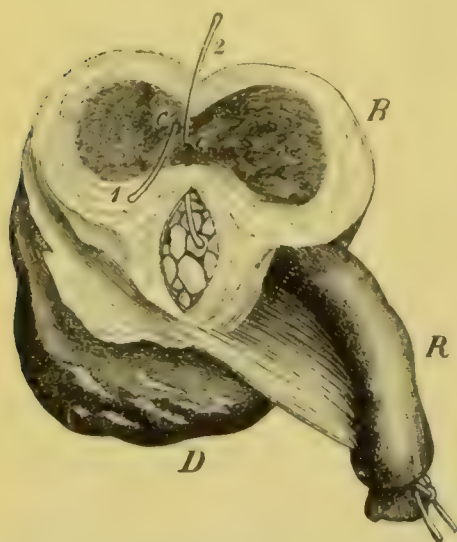


FIG. 534.—Calculi (221 in number) in a diverticulum of the bladder between the latter and the rectum: *B*, bladder; *D*, diverticulum; *R*, rectum. The probe marked 1 lies in the internal orifice of the urethra (*o*), and the probe 2 in the mouth (*o'*) of the diverticulum.

zer found two hundred and twenty-one stones in a diverticulum between the bladder and rectum which communicated with the bladder only by a narrow opening (Fig. 534). The large sac was lined throughout with vesical mucous membrane. The calculi that are found within diverticula have in some cases originated in consequence of stagnation of urine in an already existing pouch of the bladder, and in other cases the calculi give rise secondarily to the formation of a diverticulum. In the latter case the mucous membrane pushes its way outward through the hypertrophied muscular coat, and the opening of communication between the diverticulum and the bladder may grow progressively smaller, so that

the stone in the diverticulum becomes more or less completely encapsulated. Moreover, ulceration of the mucous membrane of the bladder or ureter may cause a stone to become more or less encapsulated in the wall of the bladder or of the ureter.

Small stones often pass into the urethra and remain there or escape externally, especially in females. Not long ago I removed by external urethrotomy a vesical calculus the size of a hazelnut from the prostatic urethra of a man who for eight years past had been supposed to have a stricture and had been able to evacuate his urine only with a catheter, which, being elastic, he had pushed by the stone into the bladder. No examination of the patient with a metallic catheter or sound had been made. Urinary calculi have also been found in a patent urachus.

As regards the outcome of a vesical calculus the following should be noted: In consequence of the stone or the accompanying cystitis, ulcerative destruction of the mucous membrane of the bladder sometimes occurs, which may lead to perforation of the latter. In this way a stone may enter the rectum or vagina. The cystitis often attacks the ureter and pelvis of the kidney, causing pyelitis and pyelonephritis, which may prove fatal. The fatal outcome of a stone of the bladder, which is not recognised at all or too late, is the result usually of

suppurative cystitis, ulcerative processes in the bladder, pyelitis, and nephritis with uræmia or gradual exhaustion.

The Diagnosis of Vesical Calculi.—The diagnosis of a stone in the bladder is made by exploration of the bladder with a metallic catheter or stone-searcher (Fig. 535). Thompson's searcher is provided with a slide, A, and a scale for determining the size of the stone. If the tip of the searcher is carried behind the stone and the slide, A, pushed up against the external meatus, one can determine approximately the diameter of the stone by drawing the



FIG. 535.—Thompson's searcher with a slide, A, and a scale for determining the size of a stone.

tip of the searcher forward over the stone. The distance from the slide, A, to the external meatus or end of the glans gives approximately the diameter of the stone. The stone-searchers are not solid, but are catheters which can be used when necessary for injecting or irrigating the bladder. If the stone lies free in the bladder, one hears, on striking it with the searcher, a distinct sound or "click," and a firm resistance is felt. The examination is usually more painful with an empty bladder than with the latter full. If one wishes to examine the bladder filled with an aseptic fluid, the Thompson searcher shown in Fig. 536 is used, through which a three-per-cent solution of boric acid is injected into the bladder and the cock, A, closed. It is a very good plan when the searcher is in the bladder to introduce the index finger of the left hand into the rectum and palpate the posterior wall of the bladder. One is enabled in this way to feel stones which lie in a diverticulum and can not be detected with the searcher. If the abdominal wall is relaxed, one can combine with this external palpation of the bladder above the symphysis with the other hand.

Among the other diagnostic methods of examination I mention cystoscopy (see page 280) and the use of the lithotrite (see Fig. 537, page 315). By seizing the stone between the two jaws of the lithotrite one can determine



FIG. 536.—Thompson's searcher with an arrangement at A for closing the instrument when examining a bladder filled with fluid.

both the size and hardness of the stone. If the stone is caught between the jaws of the lithotrite, the diagnosis is of course beyond all doubt, while in examination with a searcher or metallic catheter incrustations of the mucous membrane, incrustated tumours of the bladder, exostoses, and enchondromata of the pelvis, and even fæcal concretions in the rectum, have been taken for a vesical calculus.

With a view to the question of removal of a stone of the bladder by lithotrity or by lithotomy, it is of the greatest importance that one should

have an idea of the size and hardness of the stone. The size of the stone is measured approximately by means of Thompson's searcher in the way described on page 313, by a lithotrite, or by palpation through the rectum. A hard stone is recognized in a general way by examination with the lithotrite, by its external pointed contour and the different tone of the click. The soft, smooth phosphatic stones have an entirely different feeling and elicit a different click from the hard, uneven oxalate-of-lime stones.

The treatment of a vesical calculus consists in removal of the same by litholapaxy—i. e., crushing the stone and removing the fragments through the urethra—or by lithotomy. Litholysis—i. e., the method of dissolving the stone by certain chemicals, such as the injection of acids for phosphatic calculi or the administration of alkalies for stones composed of urates—has never been successful. Various mineral waters have been recommended, especially Vichy, Wildungen, Carlsbad, Tarasp, Faschingen, Vals (Desireequelle), etc. Internal medication is, however, powerless to diminish the size of a stone. Prophylaxis is of great importance—i. e., one should seek to remove the above-mentioned causes of stone, viz., chronic cystitis, foreign bodies in the bladder, gout, etc., and in this direction the mineral waters act very favourably.

§ 213. **Lithotrity and Litholapaxy.**—Only the smaller, not too hard, and freely movable stones are suited to lithotrity. Acute cystitis, if present, should be cured first. Sacculated stones are not suited to lithotrity, as they can not be seized properly. If the bladder has pouches, fragments of crushed stone may lodge in the same and give rise to the formation of a new stone. The urethra must have the necessary calibre for the introduction of the lithotrite. At one time the stone was crushed at several sittings, but now it is crushed at one sitting, and the entire *débris* removed at the same time. This improved method of lithotrity is called after Bigelow litholapaxy. The views of different surgeons vary as regards the value of litholapaxy, but personally I prefer lithotomy. Litholapaxy is employed, however, by many surgeons with excellent results. Lithotomy is performed in Germany much more frequently than litholapaxy, which has come to be a sort of special art in the hands of certain surgeons. Dittel has recently made a report of the last hundred of his six hundred cases of operation for stone, of which there were 70 litholapaxies, 22 suprapubic cystotomies, and 8 perineal sections. Of the 70 litholapaxies, 4 died, but only 2 in consequence of the operation (injury to the urethra, with sepsis). The dangers of the crushing methods depend, according to Dittel, not upon injuries to the bladder, but upon lesions of the urethra in case of hypertrophy of the prostate. Thompson collected 964 cases of operative treatment of vesical calculi, including 800 litholapaxies with 46

deaths, 115 perineal sections with 43 deaths, and 17 cases of suprapubic cystotomy with 4 deaths. Of the cutting operations Thompson prefers suprapubic cystotomy. The first lithotrity was performed successfully in 1824 by Civiale.

Lithotrity, or stone-crushing, is performed with the lithotrite. The best lithotrite was devised by Heurteloup in 1845, and he called it a *percutteur*. Although this instrument has been modified considerably, it has retained its original form up to the present time. The lithotrite (Fig. 537) consists of two blades placed one above the other, of which the upper or male one (Fig. 537, A) can be moved backward and forward in the lower or female one (Fig. 537, B) with a screw, so that in this way the beaks may be approximated and separated. The male blade



FIG. 537.—Thompson's lithotrite.

is provided with teeth and the female one with corresponding depressions. In other lithotrites—for example, Charrière's—the male blade is moved to and fro by means of a key. By means of the button, B, on Thompson's lithotrite (Fig. 537) the screw can be put out of action and brought into use again, so that it is possible to separate and close the blades without the screw.

In practising lithotrity on the cadaver the bladder should be empty. The bladder is opened above the symphysis, a brittle stone inserted, and one then proceeds in the way about to be described. By means of the incision in the anterior wall of the bladder one can control in part the manipulations inside the bladder.

The technique of lithotrity or litholapaxy is as follows: The operation is performed without an anæsthetic, or under local anæsthesia by the injection of cocaine into the urethra and bladder. It is desirable that the patient by his feelings should aid the operator in finding and seizing the stone. The patient lies on his back with the hips elevated, as this position is the most favourable for seizing the stone in the fundus of the bladder. The bladder is injected with about two hundred grammes of lukewarm three-per-cent boric acid, or one-third-per-cent salicylic acid, in order that the vesical mucous membrane may not lie in folds around the stone and be caught in the blades of the lithotrite. Some surgeons—Thompson, for example—operate with the bladder empty, with the idea that contraction of the bladder wall forces

the stone between the blades of the open lithotrite. The latter should be tested beforehand as to its strength, by crushing, for example, pieces of brick. It is sterilized by boiling it for five minutes in a one-per-cent soda solution, and before introduction placed in a warm three-per-cent solution of carbolic acid.

The lithotrite is introduced while closed into the bladder just like an ordinary metallic catheter. When in the bladder, its beak is directed downward or to the right and left toward the stone that can be felt. It is now opened wide and attempts are made to grasp the stone. The latter can also be reached by allowing the lithotrite to maintain its original position—i. e., with the tip of the beak directed upward and then raising the handle so that the beak descends and rests against the posterior wall of the bladder. If now the lithotrite is opened, the stone will fall between the blades of the beak, because the latter lies in the deepest portion of the bladder. In this way it is easier to avoid seizing the mucous membrane. When the stone has been grasped the blades are screwed together in order that the former may be firmly held. By lowering the handle the beak of the lithotrite is raised from the posterior wall and carried more toward the middle of the bladder. By rotating the instrument, especially upward or toward the right and left, one makes sure that the mucous membrane has not been caught. The stone is then crushed by closing the blades of the lithotrite. After the first crushing the larger fragments are sought for and treated in the same way. Severe pain and serious hæmorrhage occur only when the mucous membrane has been caught in the instrument. If the operation is to be performed at several sittings, the instrument is removed from the bladder after the first or second acts of crushing. It is much better, however, to perform litholapaxy as first practised by Bigelow—i. e., to crush the stone at one sitting and at the same time remove all the *débris* from the bladder, because in the old operation of lithotrity, performed at different sittings, the sharp fragments left behind may injure the bladder. The length of time consumed by the operation is usually not dangerous to the patient. The duration of litholapaxy is very variable, and may reach several hours. In a case of Gussenbauer's the stone had to be seized two hundred and twenty times, and the complete removal of the same took three hours and forty-five minutes. The patient was able to leave his bed on the third day.

After the stone has been crushed into very small pieces the lithotrite is removed from the bladder and the fragments are washed out by means of a large catheter with a wide opening, and an irrigator or syringe. The evacuators of Bigelow and Guyon are also used. The former consists of a rubber bulb, *B* (Fig. 538), which is connected

with the catheter by means of a rubber tube. The bulb is continuous below with a glass cylinder, which is fastened to a metallic stand.

The bladder is filled through the catheter with three-per-cent boric acid, and the rubber tube of the evacuator is attached to the outer end of

the catheter. By alternate compression and filling of the bulb, *B*, the contents of the bladder are aspirated and collect below in the glass cylinder.

Guyon's evacuator consists likewise of a catheter, *C*, a pear-shaped bulb, *B*, and a glass bottle, *G*, for

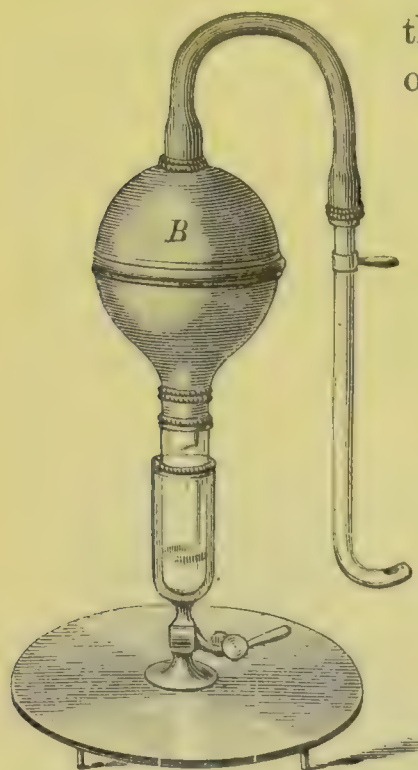


FIG. 538.—Bigelow's evacuator for litholapaxy.

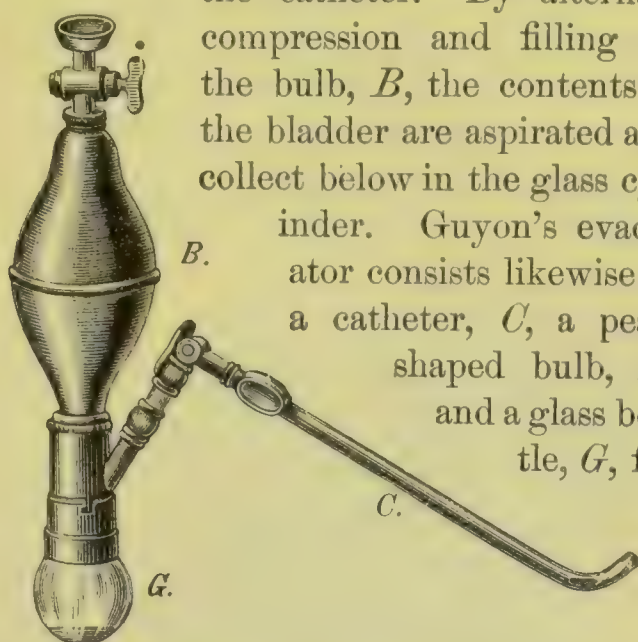


FIG. 539.—Guyon's evacuator for litholapaxy.

the *débris*. The bulb, *B*, is filled with lukewarm water, and the contents of the bladder are aspirated by alternate compression and filling of the bulb. The fragments of stone collect in the glass bottle, *G*.

After all the fragments have been removed the bladder is thoroughly irrigated with two-per-cent carbolic or 1 : 10,000–1 : 15,000 bichloride, and finally with three-fourths-per-cent salt solution, in order to remove completely these poisonous antiseptics from the bladder.

§ 214. **Lithotomy.**—By lithotomy we mean the removal of a vesical calculus by incision of the bladder. The different varieties of lithotomy which are now performed on the male are: (1) Suprapubic lithotomy above the symphysis, (2) lateral lithotomy through the perinæum, and (3) median lithotomy, also through the perinæum. Bilateral lithotomy through the perinæum and rectal lithotomy have been abandoned. The views of different surgeons are divided as to the relative value of the three methods mentioned, but it is certain that suprapubic lithotomy has of late come more and more into favour, and, as it seems to me, rightly. Like most German surgeons, I perform suprapubic lithotomy in almost every case, as it seems to me to possess the following very essential advantages over perineal section: 1. One very important advantage is that the urethra remains intact. 2. Very large

stones can be removed without breaking them up only through the suprapubic incision. 3. Sacculated stones can be easily found and removed. 4. There is but a slight possibility of overlooking or leaving behind a stone in the bladder, because one can examine the bladder with the eye and finger better than in a perineal section. 5. Suprapubic lithotomy is an easier operation, and serious associated injuries are hardly possible, as one can be sure of avoiding injury to the fold of peritonæum. Lateral lithotomy in particular has been complicated by injuries of the rectum, injuries and inflammation of the seminal vesicles, peritonitis, and impotence due to inflammatory processes. Halberstadt states that out of eighteen cases of lateral lithotomy who

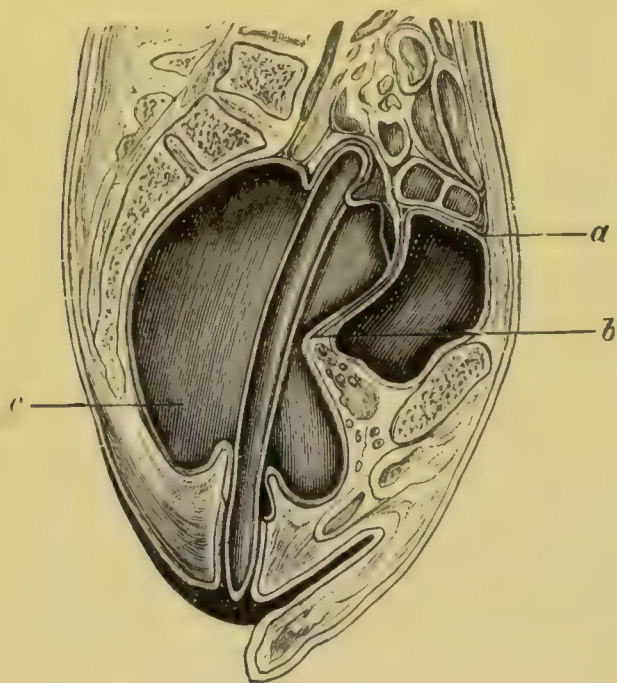


FIG. 540.—Upward displacement of the bladder by the use of a rectal tampon. The bladder contains 200 cubic centimetres and the rectum 480 cubic centimetres water. The reflection of the peritonæum (*a*) is situated 4 centimetres above the upper border of the symphysis; *b*, posterior peritoneal fold covering the posterior wall of the bladder; *c*, rectal tampon. Section of a frozen subject.

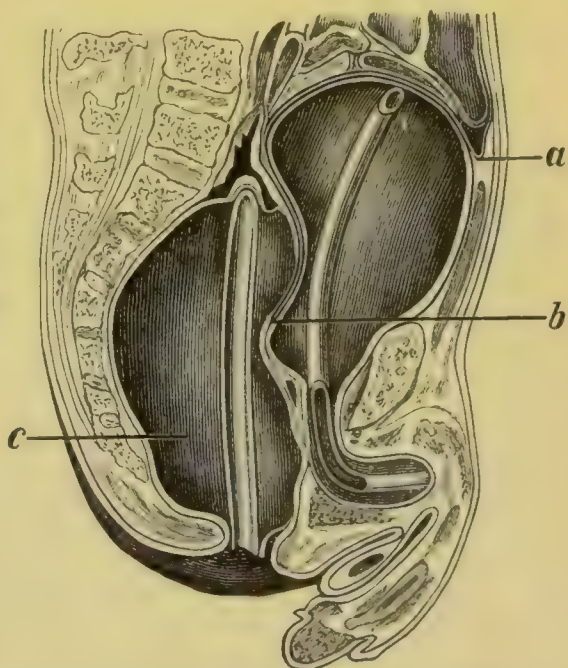


FIG. 541.—Displacement of the bladder by tamponing the rectum and filling the bladder. Section of a frozen subject. The lower edge of the peritonæum (*a*) is 8.5 centimetres above the symphysis; *b*, posterior fold of peritonæum; *c*, rectal tampon.

afterward married, only one had children. Leale saw several cases in which lateral lithotomy was followed by atrophy of the testes, absence of beard, and a high-pitched voice. Every method of perineal lithotomy has the disadvantage of injury to the urethra and its consequences (stricture). For this reason it is easy to see why suprapubic lithotomy has of late been performed with increasing frequency. Suprapubic lithotomy is absolutely indicated in the case of children and for very large stones which can not be crushed before removal. Of the perineal method, median lithotomy is the best, but it, too, has the disad-

vantage that, especially in patients advanced in age, with the neck of the bladder only slightly dilatable and with hypertrophy of the prostate, one can remove only small stones. After larger stones have been crushed, fragments are very likely to remain behind.

Suprapubic cystotomy and perineal section are also performed for injuries of the bladder and urethra, extraction of foreign bodies, etc.

Suprapubic Lithotomy, or Cystotomy.—In suprapubic cystotomy, which, as is well known, was first performed by Peter Franco in the second half of the sixteenth century, the anterior wall of the bladder is opened extraperitoneally. The parietal peritonæum is reflected from the anterior abdominal wall on to the summit of the bladder, forming a pouchlike fold, and invests its posterior wall down to the upper end of the seminal vesicles in the male, and to the junction of the middle and lower third of the bladder in the female. The position of the bladder and the peritoneal reflection varies with the amount of urine in the bladder and the age of the patient. In children this peritoneal fold is reflected on to the summit of the bladder at a greater distance from the symphysis than in the adult, and hence the extraperitoneal space between the symphysis and the point of reflection of the peritonæum is larger in the former. Disse showed that the bladder is highest in infants and then rapidly descends until the fourth year, and more slowly until the ninth year. It then remains stationary until the commencement of puberty, when it begins to descend again slowly until the completion of the growth of the body. The varying degree of distention of the bladder is also of great importance. When the bladder is empty the peritoneal fold is lower, and, especially in the adult, extends down behind the symphysis. By filling the bladder and rectum the peritoneal fold can be pushed upward four, eight, and even fifteen centimetres above the symphysis, so that the extraperitoneal anterior wall of the bladder is far enough above the symphysis to allow of suprapubic cystotomy, and injury to the peritonæum is absolutely out of the ques-

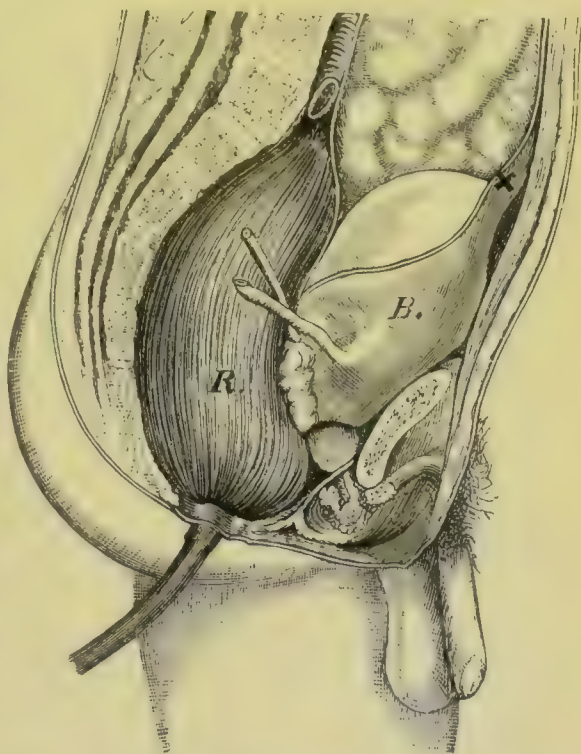


FIG. 542.—Position of the peritoneal reflection (x) when the rectum is distended with a rectal bag and the bladder is well filled. *R*, rectum; *B*, bladder; x, peritoneal reflection.

tion. Trendelenburg lays great stress upon elevation of the pelvis during the operation, and in fact this position facilitates all operative work on the bladder and in the pelvis generally.

Removal of the upper border of the symphysis with the chisel, as recommended by Helferich, is advantageous only in exceptional cases, especially in tumours of the posterior wall and the neck of the bladder. This procedure was first used by Credé for facilitating hysterectomy. The performance of the operation in two stages, as recommended by Neuber, offers no advantages.

Technique of Suprapubic Cystotomy.—The patient lies in the dorsal position with elevated pelvis. The lower abdomen and pubes are shaved, and the whole field of operation is carefully asepticated. The rectum having been previously emptied by an enema, a rectal bag or colpeurynter (Fig. 464, page 143) is introduced and filled with from three hundred to four hundred cubic centimetres of water in order to push the bladder upward. The rubber tube connected with the colpeurynter is closed by a silk thread or a clamp. A rubber bulb or condom, which is fitted over the end of a stiff hard-rubber tube, may be used in place of a colpeurynter; a piece of rubber tubing is fastened to the protruding end of the stiff-rubber tube, and, after the condom has been filled, is closed with a clamp or piece of silk. From two hundred and fifty to three hundred grammes of a three-per-cent solution of boric acid are injected under moderate pressure into the bladder through a catheter by means of an irrigator or hand syringe. A metallic catheter, provided with a cock or rubber tube, may be used for this purpose and left in the bladder as a guide during the operation. In order to prevent the escape of urine from the bladder alongside the catheter, a piece of thin rubber tubing is tied about the penis and the catheter. The distended bladder can now be plainly felt above the symphysis. In the light of recent experience the colpeurynter is but seldom employed at present, moderate dilatation of the bladder with an antiseptic fluid being usually sufficient. Trendelenburg and the author dispense with both devices.

The incision through the skin is from six to ten centimetres in length, and is made exactly in the median line. The skin, subcutaneous cellular tissue, and superficial fascia are divided until the linea alba appears. The latter is recognised as a dense cord by traction on the umbilicus with a tenaculum. The linea alba having been exposed, the two recti and pyramidales are separated from one another. Transverse detachment of the pyramidales from the symphysis is usually unnecessary. If now the transversalis fascia is divided from below upward, the loose prevesical cellular tissue comes into view. The edges of the

wound are retracted, and the prevesical cellular tissue divided with the fingers or two thumb forceps. This blunt division should begin as near the symphysis as possible. The reflection of the peritonæum is often distinctly visible in the upper angle of the wound, especially if the upper angle is drawn upward with a blunt retractor and the bladder pressed downward with the finger. If necessary, the fold of peritonæum, which can also be recognised by the presence of large veins running downward, may be bluntly separated and retracted in the upper angle of the wound with a broad, blunt hook.

The anterior wall of the bladder, which lies exposed after separation of the prevesical cellular tissue, is pushed forward somewhat in the median line by the metallic catheter lying in the bladder, secured with a tenaculum or a loop of thread, and opened with a pointed knife so that one finger can be easily inserted.

If necessary, the incision in the bladder wall is enlarged downward, its edges being retracted with tenacula. The incision should not be too large nor reach too far downward. After removal of the catheter from the bladder the latter should be carefully inspected and palpated with the finger. The stones are removed with the finger, forceps, elevator, or a scoop (Fig. 543). One should be on the lookout for sacculated stones lying in a diverticulum, and it may be necessary to cut down upon them through the mucous membrane with a blunt-pointed knife.

If the peritonæum is wounded it should be sutured with catgut.

After the arrest of any hæmorrhage and irrigation of the bladder with three-per-cent boric acid or one-third-per-cent salicylic acid the question arises whether the wound in the bladder should be sutured or not. If one decides not to suture it, it is a good plan to insert a T-shaped drainage-tube into the bladder, pack the outer wound with iodoform gauze, and have the patient lie for the next few days on his abdomen or, better, on his side—first right, and then left—so that the urine can flow out easily. Burekhardt performed external urethrot-

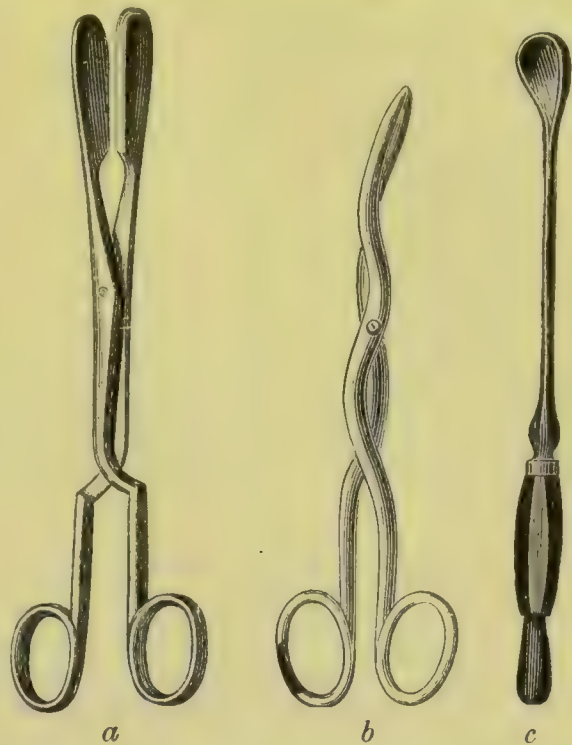


FIG. 543.—*a*, straight stone forceps; *b*, curved; *c*, scoop.

omy in addition, and inserted a thick-walled drainage-tube in order to keep the bladder empty. Bergmann, Bruns, and others recommend closing the wound in the bladder with two rows of Lembert sutures. The methods of suture used by Tiling and Antal are also serviceable. One can facilitate suture of the bladder very much by passing a long silk suture, before or after the bladder has been opened, through the wall of the bladder on each side of the incision, which should not enter the mucous membrane. With the aid of these sutures the edges of the wound in the bladder are held apart while the stone is being removed and approximated during the insertion of the sutures. For suturing, one uses small curved needles and very fine silk or catgut. The needle is inserted at some distance from the wound in the bladder and brought out near the same without piercing the mucous membrane, whereupon it is inserted on the other side of the wound and brought out a little distance beyond, likewise without passing through the mucous membrane. All the sutures are introduced in this way before any are tied. A continuous suture is inserted above this first row. The first row can also be made continuous. Brenner recommends two rows of a purse-string suture similar to that used by Dieffenbach for the closure of fistulæ—i. e., the edges of the wound are lifted up, the first ligature is carried through the submucous tissue, and the second through the muscular coat. The sutures are then drawn tight and tied. Thomson recommended for suture of the bladder the continuous ligature used by Zweifel for ligation of the stump of a myoma. Primary union of the sutured wound does not always follow. According to Dietz, who collected forty-two cases of suprapubic cystotomy followed by suture of the bladder, primary union took place in twenty-seven cases. Bramann, who obtained primary union in six cases, considers it of importance to prevent the bladder from being filled too soon and to have the patient maintain a half-sitting position so that the bladder is pressed against the symphysis. Rasumowsky thinks that the mobility of the bladder is the chief factor in the so frequent failure of its suture. For this reason he fastens the bladder by two sutures to the posterior surface of the abdominal muscles; the patient is not catheterized, but is told to urinate as frequently as possible.

The outer wound should remain open, or at most a few sutures inserted at the upper angle, but otherwise packed with iodoform gauze. For the purpose of keeping the bladder empty a permanent soft-rubber catheter with a large eye is inserted, or the patient is catheterized frequently. Antiseptic irrigations of the bladder are only necessary when there is a cystitis.

Trendelenburg has modified of late the usual method of performing suprapubic cystotomy. In place of the longitudinal incision he makes a transverse incision above the symphysis. He attaches but slight importance to distention of the bladder and rectum, but great importance to elevation of the pelvis. For securing the latter, Trendelenburg has devised a most excellent operating table. The interior of the bladder is illuminated by means of an electric bladder speculum. The bladder is not sutured, but is drained with a **T**-shaped tube for from one to two weeks, the patient lying on his side, first on the right and then on the left. It is not necessary for the patient to lie on his stomach. Out of thirty-eight cases operated on, seven died, but not in consequence of the operation. I have been operating of late in the same way as Trendelenburg.

Subpubic Cystotomy was devised by Langenbuch on the basis of his anatomical investigations. In it the bladder is opened between the lower border of the symphysis and the root of the penis. Langenbuch recommends a **A**-shaped incision—i. e., an incision passing down from the middle of the symphysis runs off into two lateral incisions that correspond with the borders of the pubic arch. After division of the suspensory ligament of the penis the latter is drawn forcibly downward and the subpubic and triangular ligaments are divided by small cuts close to the bone. The upper anterior attachments of the corpora cavernosa penis to the triangular ligament are freed with some blunt instrument, and their connection with the bone left undisturbed. The point of the knife must not penetrate too far during the division of these ligaments, as the venous plexus covering the anterior wall of the bladder may be prematurely wounded. After division of the subpubic ligament and lateral detachment of the triangular ligament the knife is exchanged for the periosteal elevator, which must also be handled cautiously. The space thus made between the pubic arch and the tissue detached from the bone, which should only in exceptional cases be enlarged by incising the triangular ligament somewhat to the outer side of its centre, is dilated by means of suitable forceps or a wooden glove-opener specially made for the purpose. In this way an entrance is gained to the anterior and lower segment of the bladder, which is from four to five centimetres in its vertical diameter. After the venous plexus lying in front of the anterior and lower portion of the bladder has been bored through with the finger, the bladder is opened by plunging in a narrow-bladed knife with its edge upward. To make it more prominent, the bladder should be previously filled with fluid, and then pressed downward beneath the pubic arch. The internal orifice of the urethra should be first located by the introduction of a metallic sound, and the knife should be inserted one centimetre above this. Upon drawing out the knife the incision is prolonged upward in the median line, and cautiously dilated with a blunt instrument. It is possible through this incision to palpate the entire bladder, especially the trigone and the ureters.

Langenbuch recommends subpubic cystotomy for (1) exploration of the bladder, (2) as a counter opening for drainage in suprapubic cystotomy, (3) for tumours, and (4) for stones that can be broken up into fragments. Injury to the dorsal vein of the penis does not cause any interference with erection.

W. Koch recommends opening the bladder through the symphysis with resection of the same for certain cases of tumour of the bladder, hypertrophy of

the prostate with retention of urine, etc. He operates as follows: A longitudinal incision is made corresponding to the symphysis, and a transverse one somewhat below the middle of the symphysis, thus forming a cruciform incision. After dissecting up the soft parts and subpubic ligament a square piece of bone about four and a half by five centimetres is chiselled out subperiosteally. This leaves as support for the symphysis a bridge of the horizontal ramus of the pubic bone, and a bony spicule from the anterior border of the obturator foramen. The bladder is opened at once, or, better, at another time, after the wound has granulated.

Perineal Section.—We have already discussed the value of the perineal methods as compared with suprapubic cystotomy. Among the various methods of perineal section we shall consider here only the lateral and median. Bilateral lithotomy, which endangers the ejaculatory duct on both sides, has been rightly abandoned altogether. Median lithotomy, in which the membranous portion of the urethra is opened, and the prostatic portion dilated by blunt means, is preferable to lateral lithotomy, because in the latter the prostate is divided obliquely and injury to adjacent parts—such as the posterior upper

portion of the prostate, the seminal vesicles, and the rectum—is possible. Infection of the wound can also give rise to impotence and peritonitis.

In performing perineal section the patient is placed in the so-called “lithotomy position”: he lies on his back near the end of the table with the gluteal region elevated, the thighs abducted, the knees and hips sharply flexed, and the legs secured in leg-holders, which will be described in § 251 (Surgery of the Female Generative Organs). Clover’s crutch is a very excellent form of “leg-holder,” which is ap-

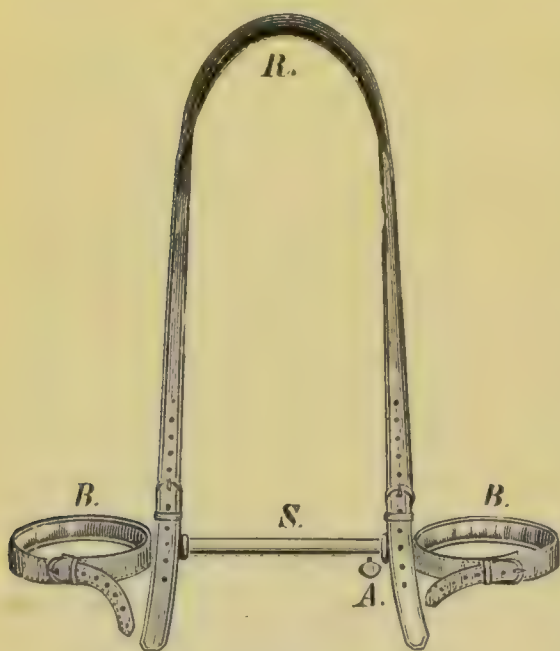


FIG. 544.—Clover's crutch.

plied with the hips flexed and the thighs rotated outward. The leg-holders, B, are connected by an iron rod, S, which can be lengthened at pleasure and fixed at the proper length by the screw, A. By means of the leather strap, R, passed about the nape of the neck, the thighs are drawn upward and held in position. Säger's crutch is a modification of Clover's. The lithotomy position can be obtained on the cadaver, and where one is short of assistants, by merely tying the hands to the feet.

Technique of Lateral Lithotomy.—The patient lies in the above-described lithotomy position, the rectum is thoroughly emptied, the perineal region shaved and disinfected, and the bladder partially filled with three-per-cent boric acid. The operator sits facing the perinæum. A grooved staff is introduced into the urethra, held in the median line by an assistant and pressed against the perinæum, so that it can be plainly felt through the latter. The scrotum is held up by an assistant. The incision through the skin extends laterally from the center of the rhaphe between the anus and posterior insertion of the scrotum to a point mid-



FIG. 545.—
Grooved staff.

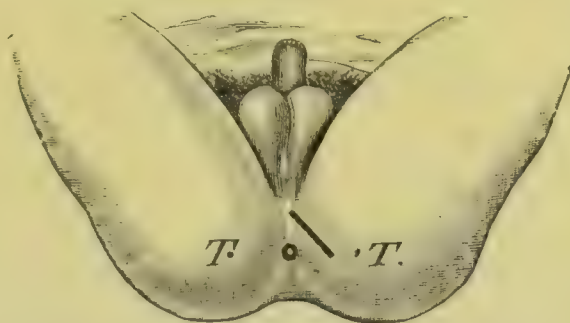


FIG. 546.—Lateral perineal section: *T*, tuberosity of the ischium.

way between the tuberosity of the ischium and the anus (Fig. 546). The superficial fascia and transverse perineal muscles are divided in the course of this incision, and the superficial perineal and

transverse perineal arteries tied. After exposure of the bulb and membranous urethra, the latter is opened just behind the bulb, so that the groove of the staff comes into view. The operator now grasps the handle of the grooved staff and brings it up firmly against the symphysis in order to draw it as far away as possible from the rectum, and protect the latter from injury during the next incision through the prostatic urethra. The operator may hold the staff in this position or intrust it to an assistant. In the latter case he then divides the prostate in an oblique direction parallel to the external wound with a

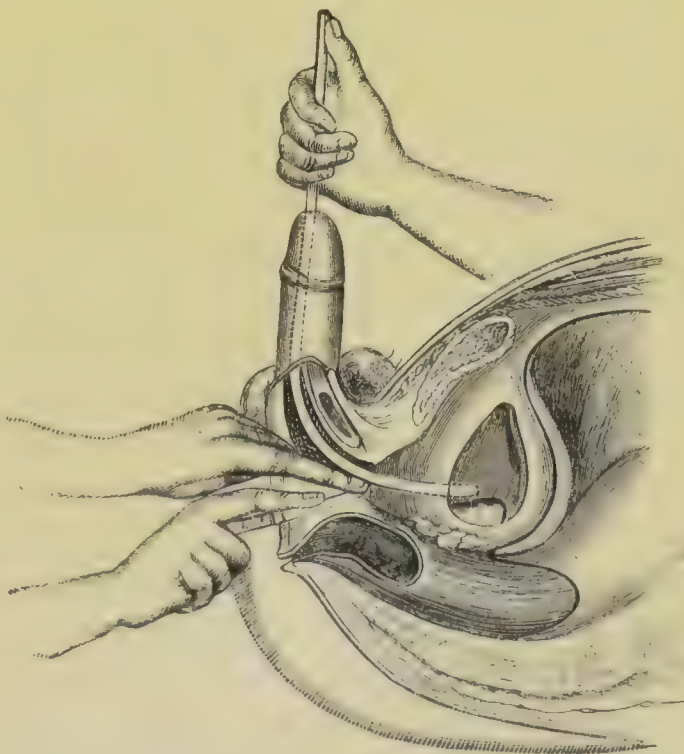


FIG. 547.—Division of the prostatic portion of the urethra in lateral lithotomy.

probe-pointed bistoury placed in the groove of the staff and under the guidance of the left forefinger. When pushing the knife along the

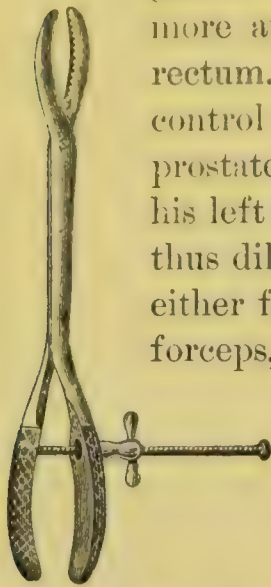


FIG. 548.—Lithoclast of Nélaton and Luer for crushing the stone in perineal lithotomy.

groove of the staff the handle of the knife should be raised more and more, so that its blade may be kept away from the rectum. By introducing a finger into the rectum one can control the direction of the knife when cutting through the prostate. The surgeon now takes the handle of the staff in his left hand and passes his right forefinger into the bladder, thus dilating its neck. The staff is then removed. The stone either falls out of itself or is removed with the finger, stone-forceps, or scoop. Large stones may have to be crushed with a lithoclast (Fig. 548) before removal. If the stone can not be broken in consequence of its hardness, and can not be extracted through the perineal wound, nothing remains but to perform suprapubic cystotomy.

After removal of the stone the bladder is carefully examined with the finger, in order to detect the possible presence of other stones. After arrest of the hæmorrhage, the bladder and wound are irrigated with an antiseptic solution, and a large, thick-walled drainage-tube introduced into the bladder and secured in the wound by a suture. The external wound is packed with iodoform gauze. Some surgeons introduce a permanent catheter into the bladder through the urethra, but this is not so good a plan as to drain the bladder through the perineal wound.

If the rectum is injured during the operation it is sutured with catgut, or the anus is divided in order to facilitate the escape of the wound secretions, fæces, and urine. For the disadvantages of lateral lithotomy, see page 318.

Technique of Median Lithotomy.—The patient is given the same position, and the staff is introduced just as for lateral lithotomy. The incision through the skin begins at the lower or posterior point of attachment of the scrotum and runs along the rhapshe to the vicinity of the anus. After division of the skin, subcutaneous cellular tissue, and superficial fascia, the bulb appears in the anterior part of the wound in the form of a bluish prominence and should not be injured. After dividing the superficial perineal fascia and the superficial and deep transverse perineal muscles, the membranous urethra lies exposed. The latter is now divided on the grooved staff from the posterior edge of the bulb toward the prostate for a distance of from 1·5 to 2·5 centimetres, the left forefinger being used to press the membranous urethra against the groove of the staff. The prostatic urethra is then dilated

either with the finger or more rarely with dilators—for example, cervix dilators or the dilators devised by Volkmann and Pajola, which are made on the plan of glove-openers. In case of hypertrophy of the prostate it is often necessary to incise its anterior surface. The extraction of the stone and the after-treatment are the same as described under lateral lithotomy. The great advantage of median over lateral lithotomy consists in the fact that in the former the prostate is either not cut at all or only in its anterior portion when hypertrophied. Median section is also to be recommended for purposes of drainage, with or without laparotomy, in injuries of the bladder—for example, penetrating gunshot wounds.

For the disadvantages of median lithotomy as compared with suprapubic cystotomy, see page 318.

For exposure of the posterior wall of the bladder through the perinæum, see page 330.

For a description of the operations for stone in the female, see § 253.

Rectal cystotomy, or opening the bladder through the rectum, and vestibular cystotomy, or opening it in the female through the vestibule, have been completely abandoned. The same is true of Dupuytren's bilateral lithotomy, in which for the purpose of extracting large stones the prostate was divided on both sides. Vidal divided the prostate by a cruciform incision (quadri-lateral lithotomy). All of these obsolete methods are merely of historic interest. Colpocystotomy, or opening the bladder through the vagina, is sometimes useful for the removal of tumours and stones from the bladder.

Mosetig-Moorhof had to perform rectal cystotomy in a case of so-called "Pfeifen-stein" ("pipe-stone"), and he thinks that it should be used in these rare cases. By pipe-stone is meant a rare form of vesical calculus which becomes impacted near the neck of the bladder, with one process projecting into the prostatic urethra. In Mosetig-Moorhof's case the pressure of the intravesical portion of the stone had caused sloughing of the posterior wall of the bladder, with the formation of a recto-vesical fistula.

§ 215. **Tumours of the Bladder.**—Neoplasms of the bladder, which of late have been minutely described by Albarran, are, generally speaking, rare, and are more common in men than in women. Papillomata are the most frequent, and then come carcinomata and sarcomata. Stones are often present at the same time.

Of the benign tumours the most common are the pedunculated mucous polyps and fibromata, the latter originating in the submucosa. Among other tumours I mention particularly the myxomata, myomata, fibro-sarcomata, and sarcomata. Fibromata and sarcomata, especially when they originate in the muscular coat, sometimes contain unstriped muscular fibres, and tumours of the trigone striped muscular fibres as well. Klebs and others have described a "tuberous fibro-adenoma"

occurring in the region of the neck of the bladder which probably originates in the prostate. Cysts are found mainly in the posterior wall of the bladder, and especially in the connective tissue between the bladder and rectum. Englisch states that they develop from remnants of embryonic structures—viz., the Wolffian body and Müller's duct—or that they are due to cystic dilatation of the seminal vesicles and the sinus prostaticus. Dermoid cysts resulting from the inclusion of cutaneous germs in the wall of the bladder are very rare (Bryant). In a case reported by Martini the posterior wall of the bladder resembled the outer integument, and was provided with hair follicles and hairs (*Trichiasis vesicæ*).

The most common neoplasm of the bladder is the papilloma or villous tumour, which is similar to the one found on the cervix uteri. It may reach the size of a hen's egg or a good-sized apple, is sometimes multiple, and is most likely to be found in the region of the fundus. The very soft papillomata that bleed easily are composed of fine vascular villi covered with layers of epithelial cells, which form the main part of the stroma. In consequence of their marked tendency to bleed, they may give rise to very serious hæmorrhages. Broken-down and separated portions of the villi are sometimes evacuated with the urine. By closing the orifices of the ureters they may give rise to hydronephrosis, and, by obstructing the internal urethral orifice, to retention of urine. Papillomata frequently develop into carcinomata, especially at their base (villous carcinoma). Every papilloma is not, however, as many think, a carcinoma from the start.

Primary carcinoma of the bladder, if we leave out of consideration the villous carcinoma just described, is rare. It sometimes appears in the form of hard or medullary nodules, and sometimes as a more diffuse flat infiltration which may spread over a large part of the bladder. Ulceration finally takes place, as a rule. The rectum and vagina are frequently attacked by the cancerous growth. Secondary carcinoma of the bladder is more common than the primary, and is due usually to the extension of a carcinoma of the rectum, prostate, uterus, or vagina. Metastatic nodules are only rarely found in the bladder wall.

The symptoms of carcinoma of the bladder consist of pain and hæmorrhages (hæmaturia), especially if the tumour breaks down. There is usually a cystitis, and the evacuation of urine may be more or less interfered with from obstruction of the internal orifice of the urethra. The occurrence of hydronephrosis from closure of the orifice of a ureter has already been spoken of. Progressive sloughing of the carcinoma may cause perforation of the bladder, with extravasation of urine, phlegmon, rupture into the rectum, vagina, etc.

Diagnosis and Prognosis of Tumours of the Bladder.—The diagnosis of tumours of the bladder is made principally by the use of the cystoscope. Important points in the diagnosis are disturbances in urination, changes in the urine, hæmaturia, cystitis, and pain. In suitable cases one may remove portions of the tumour with a lithotrite for purposes of microscopic examination. The urine should be examined for the presence of pieces of tumour tissue, especially in case of carcinoma. Bimanual examination *per rectum* should never be omitted. In the female one can palpate the inner surface of the bladder with the finger after dilating the urethra. The general condition of the patient, the hæmorrhages, the cystitis, etc., usually show whether the tumour is malignant or not.

The prognosis of carcinomata and the broad-based sarcomata is usually bad. Pedunculated benign tumours are best adapted to operative treatment.

Treatment of Tumours of the Bladder.—The operative removal of tumours of the bladder is, generally speaking, easiest in women, with whom it may only be necessary to dilate the urethra in order to excise the growth (see Surgery of the Female Urinary Organs). Tumours of the bladder in the male are best removed, as a rule, by performing suprapubic cystotomy. Pedunculated tumours are then cut away with the knife or scissors after tying the pedicle with catgut. The thermo-cautery, galvano-cautery, and galvano-caustic loop may also be used in suitable cases. After removal of the tumour the entire wound is packed, or the wound in the bladder is sutured and the cutaneous incision left open, and for the next eight to twelve days a permanent soft-rubber catheter is used. Guyon, Tuffier, and others recommend suturing both the bladder and the external wound. Tuffier omits even the insertion of a permanent catheter, which is, of course, only possible in case of sure asepsis of the interior of the bladder. Sessile tumours, such as sarcomata and carcinomata, may be removed by extirpation or resection of the bladder. For this purpose laparotomy or suprapubic cystotomy, with possible resection of the symphysis, is performed, or a perineal route is chosen. The latter is adapted especially to tumours of the base of the bladder. Kocher removed a carcinoma of the bladder after first performing median perineal cystotomy, and obtained a complete cure. Sonnenburg resected with success two thirds of the bladder for carcinoma. Antal removed a carcinoma in a man sixty-one years old after resection of the apex of the bladder, the peritonæum being first detached and pushed back. Bramann operated upon two cases in the following way with good success: 1. Longitudinal incision in the linea alba. 2. The points of insertion of the recti muscles chiselled from the symphysis. 3. The bladder opened. 4. Removal of the tumour. 5. Suture of the bladder. 6. Fixation of the two pieces of bone in their normal place, where they unite again firmly. Niehans

recommends the following method of osteoplastic resection of the anterior pelvic wall for extraperitoneal exposure of the bladder and adjacent structures: 1. Cutaneous incision in the linea alba as far as the symphysis, and then past the penis to about the middle of the ascending ramus of the ischium. 2. Subperiosteal division of the latter in the lower angle of the wound and of the horizontal ramus of the os pubis close to the inner side of the femoral vein. 3. Separation of the symphysis and turning out of the portion of the bone thus chiselled through. After completion of the operation on the bladder or its vicinity, or some days later, the osteoplastic flap is replaced and secured by wire sutures. For a description of resection and extirpation of the bladder, see page 331.

Dittel and Zuckerkandl have devised an operation for exposure of the posterior wall of the bladder for the purpose of removing tumours

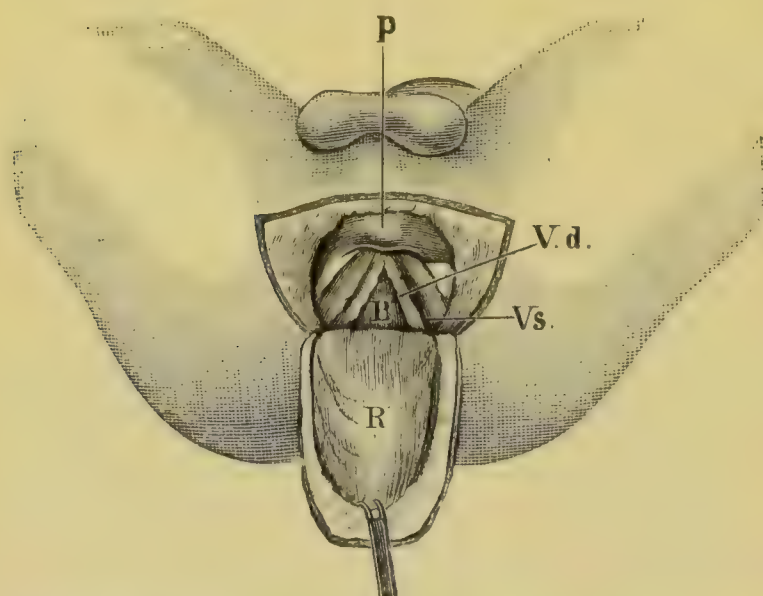


FIG. 549.—Exposure of the posterior wall of the bladder for the removal of tumours of the fundus and the prostate (Dittel and Zuckerkandl): *B*, bladder; *P*, prostate; *Vs.*, seminal vesicles; *Vd.*, vas deferens; *R*, rectum.

of the base of the bladder and the prostate. The patient is placed in the lithotomy position, and a perineal flap is cut in the way shown in Fig. 549. In making this flap the transverse incision is three centimetres from the anus, and the lateral incisions pass backward to the level of the anus with a slight curve. After division of the skin and subcutaneous cellular tissue the fibrous

septum of the perinæum is cut through by directing the blade of the knife forward, so as not to injure the anterior wall of the rectum. When above the sphincter ani one should proceed by blunt dissection, pushing the bulb and Cowper's gland forward and the exposed rectum backward. The posterior border of the prostate is now seen between the portions of the levator ani that arise from the pubic bone. The rectum is then separated bluntly from the base of the bladder, whereupon the prostate is pushed forward, and the posterior wall of the bladder comes into view with the vas deferens and seminal vesicles. If one wishes to expose still more of the posterior wall of the bladder

extraperitoneally the rectum is drawn firmly backward, which puts the peritonæum on the stretch and allows the latter to be separated from the posterior vesical wall and pushed upward.

Pousson collected 198 cases of operation on tumours of the bladder, including 126 men and 72 women, and out of these 46 died, 141 recovered, and in 11 the result is unknown. In the male patients the tumours were removed partly by perineal section and partly by suprapubic cystotomy, while in females dilatation of the urethra was often sufficient.

§ 216. **Resection and Extirpation of the Bladder.**—Resection or complete extirpation of the bladder, which was first performed experimentally on dogs by Poggi, Tizzoni, Schwarz, and others, is employed on the human subject for malignant tumours. Depending on the location of the tumour, the bladder is exposed for resection either by laparotomy, suprapubic section, with or without chiselling away the upper border of the symphysis or by perineal section. Attempts to get a still better exposure of the bladder by osteoplastic resection of the symphysis or by symphysiotomy have not proved very successful. Suture of the bladder is employed mainly after suprapubic cystotomy.

Complete extirpation of the bladder is best accomplished through a longitudinal or transverse incision above the symphysis, and the ureters are treated in different ways. Bardenheuer recommends an extraperitoneal transverse incision above the symphysis, suturing the ureters into the rectum, and, if possible, preserving a piece of the bladder to be transplanted below. Pawlick reported a case of extensive recurrent papilloma of the bladder in a woman, in which he transplanted both ureters into the anterior vaginal wall, then extirpated the bladder and performed *colpocleisis*, thus making a new bladder out of the urethra and vagina. Küster used the following method in the complete extirpation of the bladder and prostate: The patient being placed in the Trendelenburg position, the bladder is exposed above the symphysis, the rim of the pelvis is partly chiselled away, and the bladder opened for the purpose of inspecting its interior. The incision in the bladder is then closed tight, and the bladder freed by blunt means from its surroundings, any tear in the peritonæum being sutured at once. An incision is now made in the median line of the perinæum, the urethra divided transversely, and the prostate seized and freed with the fingers and scissors. In order to locate the ureters exactly, the incision in the bladder is reopened. The ureters, having been exposed, are tied off loosely with a silk thread, and then cut away in an oblique direction from in front backward and upward. The remaining connections of the bladder are now freed by a few cuts with the scissors. The ureters are finally sutured into the rectum.

Sonnenburg performed complete extirpation of the bladder for exstrophy of the same, and sutured the ends of the ureters into the groove on the upper surface of the penis.

Bardenheuer extirpated with success the diseased mucous membrane of the bladder through a transverse incision above the symphysis. The bladder was then packed. After healing took place the patient was able to hold his urine for two hours and a half.

Novaro was successful in his attempt to suture the ureters into the rectum with preservation of the bladder. The dog in question subsequently passed all his urine through the rectum, and was perfectly well. Upon killing the dog it was found that the bladder had shrunk to a round body the size of a hazelnut. In the human subject Küster, Giordano, Trendelenburg, and others have successfully implanted the ureters into the rectum, and Chaput and others into the large intestine. Rose has made the condition of patients bearable, with an incurable defect between the bladder and vagina, by forming a recto-vaginal fistula and closing the vagina (colpocleisis). When possible, the best plan after extirpation of the bladder is to implant the ureters into the urethra or the neck of the bladder.

Tizzoni and Poggi formed in a dog after complete removal of the bladder a new bladder out of intestine. A loop of intestine was first isolated, and then at a second operation its lower end sutured to the neck of the extirpated bladder and the ureters implanted above. After incontinence at the outset, normal evacuation of urine followed. Tizzoni and Poggi have also tried to substitute intestine for the bladder at one operation, but only one dog survived more than eight days,

CHAPTER XXIV.

INJURIES AND DISEASES OF THE URETHRA AND PENIS.

Deformities of the Urethra: Epispadias.—Hypospadias.—Atresia and absence of the urethra.—Congenital strictures and dilatations of the urethra.—Double urethra.—Fistulæ.

Injuries of the Urethra: Foreign bodies.—Urinary calculi.—Inflammation (Urethritis).—Gonorrhœa.—Tumours.—Tuberculosis.—Strictures.—External and internal urethrotomy.—Urethral fistulæ.

Congenital and Acquired Deformities of the Penis: Absence of the penis.—Double penis.—Rudimentary development.—Fissure.—Congenital fistulæ of the penis.—Phimosis (congenital and acquired).—Paraphimosis.—Preputial concretions.

Injuries of the Penis: Inflammations.—Balanitis (balanoposthitis).—Herpes præputialis.—Phlegmon.—Gangrene of the penis.—Soft and hard chancre.—Tumours.—Gummata.—Tuberculosis.—Elephantiasis.—Aneurisms.—Amputation of the penis.

§ 217. **Deformities of the Urethra and Penis.**—The most common deformities of the urethra are epispadias and hypospadias.

Epispadias.—By epispadias we mean that deformity of the urethra or penis in which the upper wall of the urethra is closed only in part or not at all, but forms an open groove. The following three degrees of epispadias are distinguished:

1. Epispadias of the glans, which is very rare. The urethral opening is situated behind the glans, and the urethra of the glans runs along the upper surface of the latter in the form of an open groove.

2. Epispadias of the penis in which the urethral opening is situated on the dorsum of the penis, just in front of the symphysis. A broad, shallow groove is seen on the upper surface of the rudimentary penis, which extends from the glans to the symphysis. The symphysis is either normal or divided—i. e., there is a diastasis of the same.

3. The most frequent and worst form of epispadias is the one combined with exstrophy of the bladder. The urethral groove on the upper surface of the rudimentary penis continues into the bladder, the anterior wall of the bladder is wanting, and the posterior wall bulges forward in the form of a reddish tumour above the symphysis (Fig. 550). The urine exudes continuously from both ureteral orifices. There is usually a double inguinal hernia present at the same time.

The symphysis is open. Epispadias is sometimes associated with other malformations, such as urachal fistula, imperforate anus, absence of the prostate, abnormalities of the corpora cavernosa, etc.

For a description of the etiology of epispadias, with or without exstrophy of the bladder, see page 284.

The functional disturbances are most marked in complete epispadias with exstrophy of the bladder. In such cases there is incontinence of

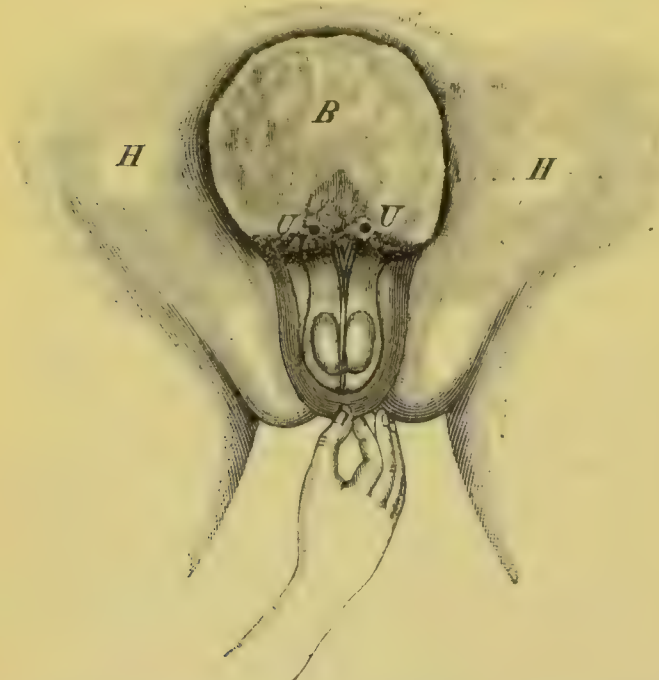


FIG. 550.—Exstrophy of the bladder combined with epispadias: *B*, mucous membrane of the posterior bladder wall; *U*, ureters; *H*, inguinal hernia.

urine, with constant wetting of the neighbourhood of the genitals and the clothing with urine that escapes in drops. This perpetual wetting of the skin predisposes to eczema, and such individuals are deprived of all pleasure in life. This incontinence is easy to understand when the epispadias is associated with exstrophy of the bladder, for here the anterior wall of the bladder is wanting and the sphincter and upper part of the neck of the bladder are open. The prostate is also absent at times. If the bladder is

normal, the symphysis closed, and there is complete epispadias of the penis, the proximal portion of the urethra is then too much dilated, and although the sphincter may be present, it does not perform its function perfectly, because its upper circumference is not entirely closed, or is at least too much stretched. Incontinence is not present in the rare cases of glandular epispadias, and this may be true exceptionally in complete epispadias of the penis when the sphincter and neck of the bladder are normal. Erection of the penis is normal in epispadias, so that coitus is possible. The procreative power is present, however, only in the rare cases of glandular epispadias, but usually not in complete epispadias of the penis, because during coitus the semen escapes outside the vagina. For other manifestations of exstrophy of the bladder see page 283.

The prognosis of epispadias has been improved since the recent general introduction of operative treatment. The chief difficulty consists—after restoring the urethra—in overcoming the incontinence,

which can probably be done most surely by Trendelenburg's new method. One sometimes finds that the patient—after healing has taken place—can hold his urine for from one to two hours. If incontinence persists after the operation, nothing remains except to close the urethra at the root of the penis by pressure with a pad or India-rubber ring, or have the patient carry a urinal.

Treatment of Epispadias.—There are various methods for the operative treatment of epispadias, of which Thiersch's seems to me the best. One can also adapt Duplay's operation for hypospadias to this condition (see page 340). We shall take up in detail only Thiersch's operation, which suffices for all cases. For a description of the other methods the reader is referred to Kaufmann's work (*Deutsche Chirurgie*, Lieferung 50, *a*). Thiersch's operation for complete epispadias consists of five steps :

1. Formation of a perineal fistula in order to keep the urine away from the field of operation. A male sound or the left forefinger is passed into the bladder, the neck of the bladder pressed against the raphé of the perinæum, and an incision made in the latter in front of the anus. The wound is kept open by inserting a metallic or rubber tube, so that a fistula is formed.

2. The operation itself begins with the formation of the glandular urethra. Two longitudinal incisions are made, one on either side

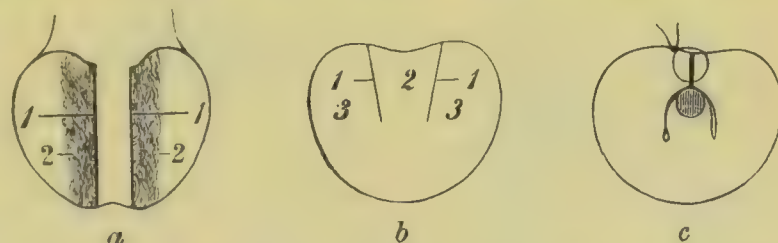


FIG. 551.—Thiersch's operation for epispadias: Restoration of the glandular urethra.

of the groove on the glans, which converge somewhat as they go deeper (Fig. 551). The surface of the glans to the outer sides of the longitudinal incisions is freshened by the removal of narrow strips (Fig. 551, *a* 2), and both lateral portions (Fig. 551, *b* 3) are then drawn over the middle portion (Fig. 551, *b* 2), which contains the groove of the urethra, and the freshened surfaces of both lateral flaps are sutured together over the groove. The result on cross-section is shown in Fig. 551, *c*.

3. The third step consists in transforming the groove on the upper surface of the penis into a closed canal. The incision I is first made close to the groove (on the right side of the patient), and then the incision II on the left side about one centimetre to the outer side of the groove. A transverse incision is made at both ends of the longitudinal incisions. Both rectangular flaps are dissected up from the subjacent tissue, and should be as thick as possible. The flap marked II (left

side of patient) is turned over the groove on the penis so that its epidermic surface is directed toward the groove and its wound surface outward. Flap I is then placed upon flap II, and secured in the

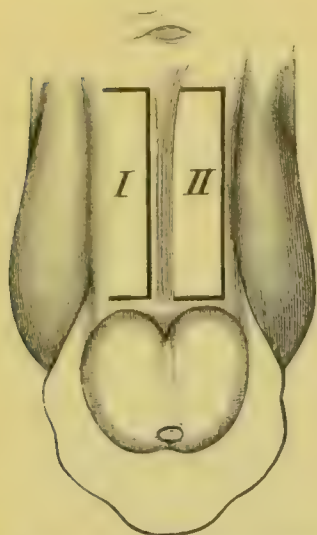


FIG. 552.—Thiersch's operation for epispadias: Restoration of the penile urethra.

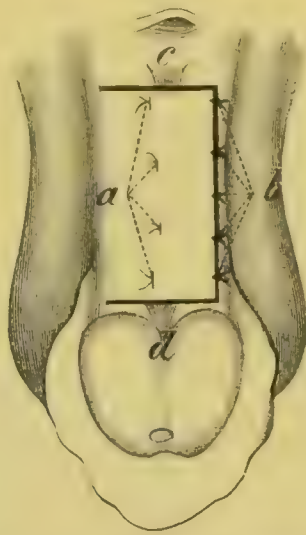


FIG. 553.—Thiersch's operation for epispadias: Restoration of the penile urethra.

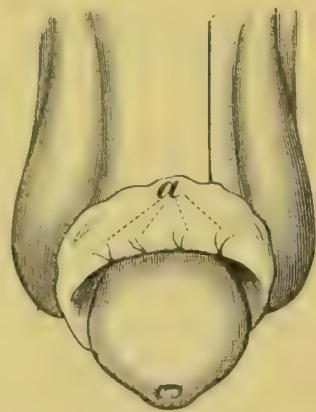


FIG. 554.—Thiersch's operation for epispadias: Closure of the slit between the glandular and penile urethra.

following way: Three or four fine silk sutures are passed through the free border of flap II, both ends of which are threaded into needles. Both needles of each thread are passed through flap I, which is laid

over flap II, the threads tied, and both flaps fastened together in this way. The free border of flap I is then secured with interrupted sutures (Fig. 553, *b*). Fig. 553 shows the result that follows.

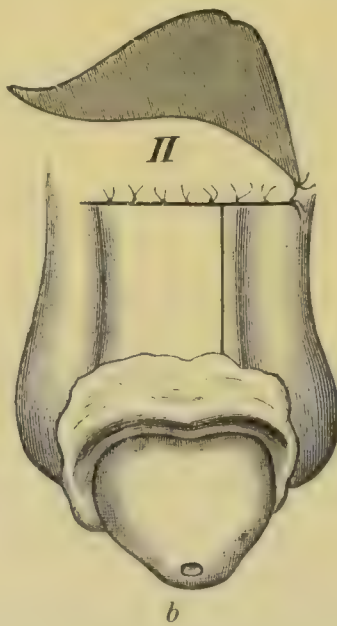
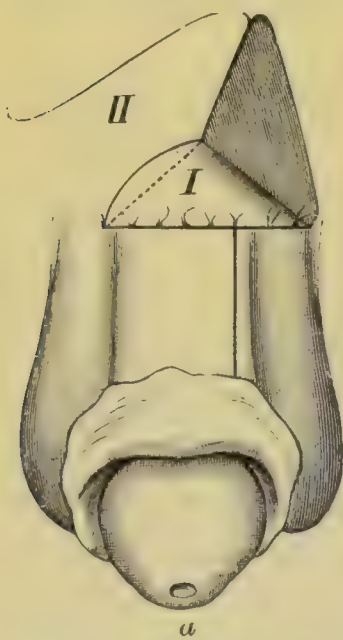


FIG. 555.—Thiersch's operation for epispadias: Closure of the funnel-shaped opening behind the penile urethra.

the penis. The space between the glandular and penile urethra is first freshened, and then the prepuce, which has been slit open, is drawn over the glans and secured with interrupted sutures (Fig. 554, *a*).

5. The fifth step aims at closing the funnel-shaped depression be-

4. In the fourth step the penile portion of the new urethra is joined to the glandular urethra by slipping the glans through a slit in the broad foreskin on the under surface of

hind the new penile urethra with doubled flaps from the adjacent skin of the abdominal wall (Fig. 555, *a* and *b*). The cutaneous flap I (from the left side of the patient) is first formed, which has the shape of a triangle with equal sides. This cutaneous flap is turned downward with its skin surface inward in such a way that its free upper border can be united to the freshened upper edge of the new covering of the penis (Fig. 555, *a* I). A long quadrangular flap, II, with its pedicle in the vicinity of the right inguinal canal, is then placed upon the wound surface of the cutaneous flap, I. Flap II is sutured over flap I in the way shown in Fig. 555, *b*. The resulting defect is covered at once with skin-grafts.

In order to overcome the incontinence that exists in epispadias it is a good plan to narrow the funnel-shaped channel leading from the bladder in the way devised by Trendelenburg. This is done either as a preliminary operation or at the same time that the new urethra is formed, and consists in dividing the upper wall of the funnel-shaped channel and the urethra in the median line toward the symphysis, and uniting the divided portions with Lembert sutures so that the abnormally wide urethra is considerably narrowed up to the vicinity of its internal orifice. Trendelenburg's patient was able to hold his urine for from two to three hours.

The last step in the operation consists in closure of the perineal fistula, which usually takes place spontaneously. The length of time required for the treatment is from three to four months.

Rosenberger cured an epispadias in a child two and a half years old in the following way: The dorsum of the penis was first freshened to a width of half a centimetre on both sides of the groove from the glans to the skin of the abdomen. Two corresponding parallel strips of skin were then excised from the skin of the abdomen, and the penis was sutured to the abdominal wall in such a way that the freshened borders of the penis covered the parallel wound surfaces on the abdomen. The penis healed in place by primary union, and the groove on its dorsum became a canal. The penis was subsequently dissected from the abdominal wall and the wound surface on its dorsum covered with a flap from the abdomen.

If the epispadias is complicated by exstrophy of the bladder, which is often the case, this should be treated as soon as the epispadias has been cured.

Hypospadias.—In hypospadias the urine is evacuated through an opening on the under surface of the penis. It is the most common deformity of the male urethra. Rennes, Kaufmann, and others estimate one case of hypospadias for every three hundred individuals. As in epispadias, different degrees of the deformity can be distinguished.

1. The mildest form is the glandular hypospadias, in which the urethral opening is found where the frenum is situated under normal conditions. The thick portion of the prepuce is situated not upon the under surface of the penis but upon its dorsum. There are sometimes two or three or even more urethral openings present. There is usually a groove on the under surface of the glans which extends posteriorly from the site of the normal meatus to the hypospadiac opening. In some cases the urethra of the glans is entirely absent, so that one can find neither a groove on its under surface nor any sign of an external urethral opening in the otherwise normal glans. The penis is in other respects not changed in glandular hypospadias in children, while in adults the glans is not infrequently deflected to one side. In rare cases the penis is adherent to the scrotum.

2. The second degree of hypospadias is the penile form, in which the urethral opening is situated at any other point on the under surface of the penis as far back as the peno-scrotal junction. The portion of the urethra situated in front of the urethral opening is usually visible in the form of a shallow groove extending to the end of the glans. This groove is sometimes absent or the glandular urethra is present in the form of a closed canal, which either ends blindly behind or the meatus is closed at the tip of the glans. The scrotum is usually divided into two distinct halves by a fissure that has a cicatricial appearance. The penis is generally smaller than normal and during an erection curves downward or toward the side. It is not infrequently adherent to the scrotum, but to a less degree than in glandular hypospadias.

3. In the third degree of hypospadias, which is the rarest, the scrotum is divided by a deep fissure into two distinct halves, with the urethral opening at the bottom of the furrow about four to five centimetres from the anus. The portion of urethra situated in front of this is either completely absent or forms a shallow groove or a canal closed in front or behind. The penis is usually only rudimentary, is curved downward, and fixed so that at first sight it is difficult to determine the sex of the individual. Male patients are particularly likely to be mistaken for females when the testes are in the inguinal canal and the two halves of the scrotum are taken for the labia majora. A few years ago a patient who was thought to be a woman with a remarkable growth of beard, and had been happily married for more than twenty years, was admitted to the Leipsic clinic for some other disease. Examination of the genitals showed that the patient was really a man with perineal hypospadias. In consequence of coitus, the groove between the two scrotal halves had become deepened. In

order not to disturb the conjugal happiness of the couple the patient was not told of his real sex.

As far as the origin of hypospadias is concerned, similar conditions are present as in epispadias (see page 284). According to Reichel, the different varieties of hypospadias are the result purely of arrested development, and the farther posteriorly the urethra opens, the earlier the hypospadias has developed. Perineal hypospadias develops at about the sixth to the seventh week, and glandular hypospadias at the end of the third or beginning of the fourth month of foetal life.

The functional disturbances in hypospadias consist, first of all, of difficulties in evacuation of the urine when the urethral opening is too small. Incontinence is sometimes present, so that the urine escapes in drops from the urethra, especially in perineal hypospadias. Sexual intercourse is impossible in case the penis is extensively adherent to the scrotum, is abnormally curved on itself, as well as in perineal hypospadias. In case the penis is otherwise normal the presence or absence of sterility depends upon whether the urethral opening lies during coitus within the vagina, so that the semen can enter the latter. The farther forward the urethral orifice is situated, the more likely is the individual in question to be capable of procreation. Certain travellers have reported that in Australia there is a sort of castration practised which consists in producing hypospadias artificially by slitting open the whole length of the urethra along the lower surface of the penis. By inserting a foreign body they prevent reunion of the edges of the wound. As in epispadias, cases of hypospadias have been observed which had apparently healed during intra-uterine life. The prognosis of hypospadias depends upon the degree of the deformity. In the more marked cases a number of operations are necessary, as in epispadias.

Treatment of Hypospadias.—The treatment of hypospadias varies, of course, with the variety of the same. We shall consider first penile and perineal hypospadias, where in place of the penile urethra there is a shallow groove and the urethral opening is in the vicinity of the peno-scrotal junction. The treatment of other abnormalities will be taken up more in detail later on. The absent portion of the urethra in front of the urethral opening is restored on the same principle as in epispadias. Thiersch's operation for epispadias is to be chiefly recommended here. Duplay's method is also very serviceable, and consists of three stages: 1. Detachment of the penis from the scrotum and restoration of the glandular urethra. 2. Formation of a new urethral canal from the corona glandis to the hypospadic opening. 3. Closure of the slit between the hypospadic opening and the new urethra. Du-

play performs the first step in about the fourth year, the second in the fifth to the sixth, and the third at the age of puberty, as a certain amount of intelligence on the part of the patient is necessary.

The penis is detached by means of a transverse incision midway between the glans and the hypospadiac opening, the penis being pulled upward and put on the stretch. A rhomboid-shaped wound results after straightening the penis, which is covered with skin-grafts, as suture of the wound longitudinally is usually unsuccessful. Duplay

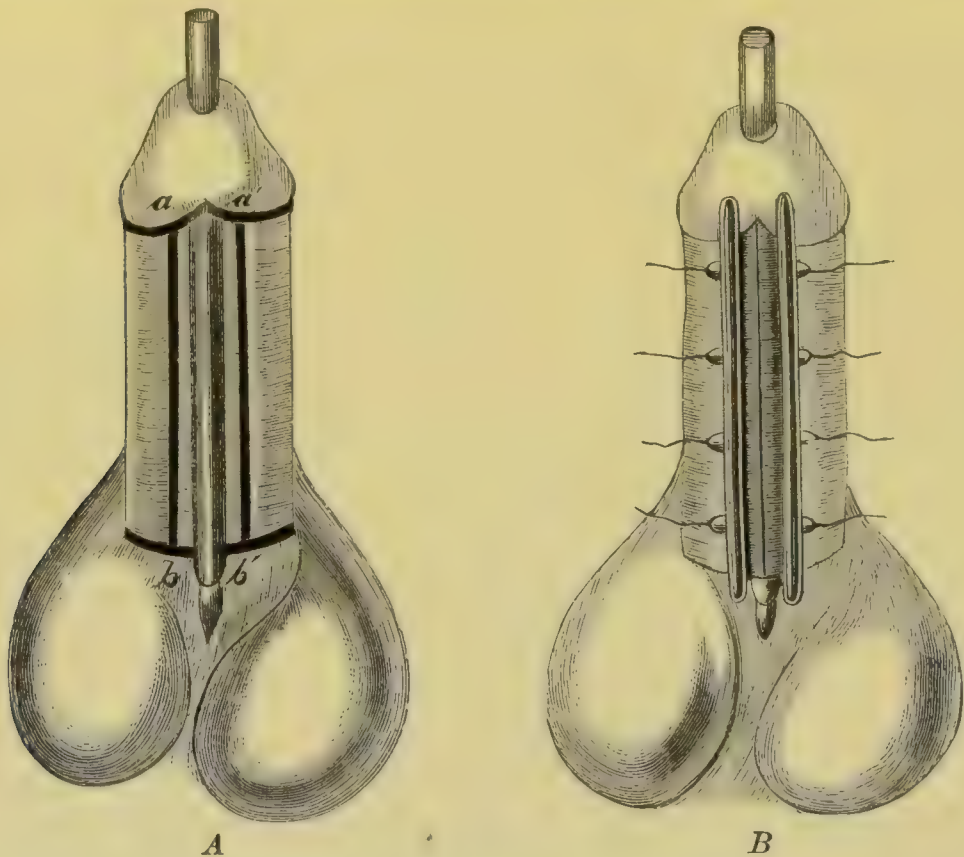


FIG. 556.—Duplay's operation for hypospadias.

combines detachment of the penis with restoration of the glandular urethra, which he accomplishes, in case of a deep groove, by freshening the edges of the same and suturing them over a catheter.

Duplay forms the new penile urethra as follows: A longitudinal incision is made on each side of the under surface of the penis a few millimetres from the median line, and at both ends of these a transverse incision externally (Fig. 556, A, *ab*, *a'*, *b'*). The inner edge of each longitudinal incision is dissected up slightly, while the external edge is dissected freely so as to make a broad flap. These flaps are then united over a catheter by quilled sutures of silver wire inserted half a centimetre apart and held with perforated shot (Fig. 556, B). The edges of the skin are united, in addition, with interrupted sutures.

Closure of the hypospadiac opening—or, in other words, union of

the new urethral canal with the one already existing—is accomplished by making broad freshened surfaces and uniting them by exact suture. Duplay covers the space between the glandular urethra and the newly formed urethra by the same method that Thiersch employs for epispadias—i. e., he makes use of the prepuce, separating both layers in order to obtain a broader surface.

Wood's method should also be mentioned. He draws the glans through a buttonhole in the prepuce just as Thiersch does for epispadias. He then uses the skin of the lower surface of the penis and the scrotum to make an oblong flap with its base anterior, which is turned forward so that the skin surface is directed toward the urethral groove. The anterior border of the flap is sutured to the cut edge of the prepuce, and its lateral borders with the freshened lateral portions of the urethral groove.

One can also use a modification of Rosenberger's operation for epispadias—i. e., the penis is freshened on both sides of the urethral groove and two corresponding strips of skin are removed from the scrotum, whereupon the penis is sutured to the scrotum. Six or eight weeks later the penis is dissected from the scrotum, the under surface of the former covered with skin, and the defect in the scrotum closed.

Other Deformities of the Urethra and Penis.—In very rare cases absence or complete obliteration of the urethra occurs. The penis may likewise be wanting, so that very marked disturbances of development may be present. Kaufmann collected from literature eight cases of complete absence of the urethra. Of these, only one foetus had died from retention of urine, and in the other cases the urine had escaped either by reopening the urachus at the umbilicus or by rupturing into the rectum. Four cases were successfully treated by operation (see page 342).

Partial occlusion of the urethra is more common. In the mildest cases there is only membranous closure of the external meatus. In other cases the entire glandular urethra is impermeable (*imperforatio glandis*), or there is an occlusion varying in extent at some one point in the urethra. Atresia of the glandular urethra and more or less of the *pars spongiosa* are the most common. Occlusion of the internal orifice of the urethra is very rare, Kaufmann mentioning but three cases.

In all cases of congenital occlusion of the urethra retention of urine results, with dilatation of the portion of the urinary apparatus situated behind it—i. e., the urethra, bladder, ureters, and pelvis of the kidney. The foetus may die in from seven to eight months in consequence of the retention, or earlier if the atresia lies nearer the bladder. The bladder may be so distended that it offers a hindrance to birth. The urachus may open in consequence of the retention, the urine escapes through the umbilicus, and the children are born with a urachal fistula. The bladder may also rupture into the rectum or through the abdominal wall, giving rise to exstrophy. Most frequently, however, the urethra itself ruptures in case of closure of its distal

portion, causing hypospadias, or, more rarely, epispadias, with or without exstrophy of the bladder. One should always bear in mind the possibility of occlusion of the urethra in infants, so that it may be remedied as promptly as possible.

The treatment of occlusion of the urethra is simplest in membranous closure of the external meatus. One can often in such a case break through the membrane with the end of a probe or puncture it with a fine-pointed knife, and in this way secure at once an outlet for the urine. Closure of the internal orifice of the urethra has also been remedied by introducing a catheter, which easily broke through the adhesion.

In case of occlusion or absence of the glandular urethra, a small trocar or hollow needle is stuck through from the tip of the glans in the probable direction of the anterior end of the urethra, and the newly formed canal is kept open by inserting a metallic tube or laminaria stick (Voillemier). I cured two cases of imperforatio glandis in this way.

Other occlusions of the urethra at any one place are treated as follows: A catheter or probe is introduced down to the occluded point and a careful attempt is made to bore through it. Ebert, Rose, and others push a small trocar into the bladder through the occluded part of the urethra and in a direction corresponding to its course. This method is not reliable, and hence not to be recommended. For extensive atresia of the posterior portion of the urethra Kaufmann recommends exposure of the latter by an incision in the perinaeum and opening the urethra at a point depending on the situation of the occlusion. Through this opening one can make a passage proximally toward the bladder or distally toward the glans. The same procedure should be used for complete absence or occlusion of the urethra with the penis present.

If there is urgent need of overcoming the retention, one should puncture the bladder above the symphysis and then later attempt to remedy the obstruction in the urethra.

Congenital Strictures of the Urethra.—Stenosis of the external meatus with a corresponding difficulty in urination is comparatively common. This can be easily remedied by incising the meatus toward the frenum and suturing the edges of the glans to the mucous membrane of the urethra. In the more marked cases one may dissect up the urethral mucous membrane and then suture it to the skin.

The congenital strictures that are found in different portions of the urethra usually have the form of valves or folds of the mucous membrane, and occur most frequently in the fossa navicularis as a remnant of the foetal septum between the glandular and penile urethra and in the prostatic portion. Congenital annular strictures are very rare.

But little is known of the treatment of congenital strictures of the urethra. They have been successfully treated by the insertion of laminaria or bougies or by the introduction of sounds. Operative procedures, such as an external or internal incision for the purpose of remedying a valvular or annular stricture, are but very seldom necessary.

Congenital Diverticula of the Urethra.—Dilatations of the inferior wall of the urethra occur in the form of diverticula, which usually begin behind the glans and may extend to the peno-scrotal junction. A characteristic case

observed by Laugier is shown in Figs. 557 and 558. When empty, these diverticula form saclike dilatations on the lower surface of the penis, while

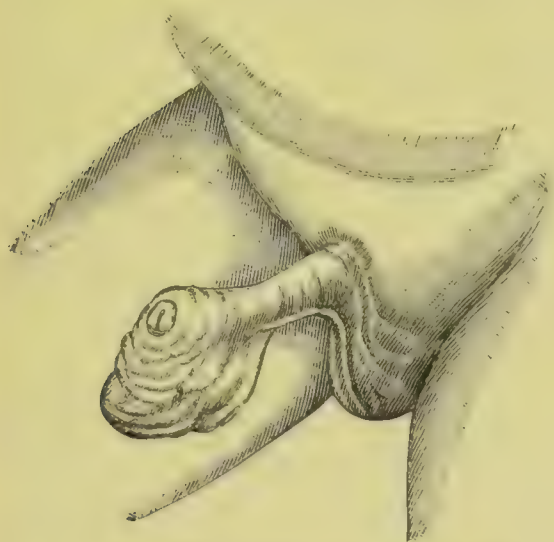


FIG. 557.—Empty diverticulum of the urethra (Laugier).



FIG. 558.—Distended diverticulum of the urethra (Laugier).

during urination they become more or less distended to the size of a pigeon's or hen's egg (Fig. 558). Extreme phimosis can in the same way cause the urine during urination to collect between the glans and prepuce. According to Kaufmann, diverticula are mainly the result of foetal retention of urine due to disturbances in the union of the glandular and penile urethra. The membrane at the junction of the glandular and penile urethra probably persists for an abnormally long time, the retention of urine causes a saccular dilatation of the lower wall of the urethra, the obstruction is at last overcome, and as a remnant of the septum one may find the tongue-shaped processes described by Hueter (Fig. 559). The latter are not the real cause of the deformity, but they tend to increase the saccular dilatation of the lower wall of the urethra by interfering with evacuation of the urine through valvular closure of the urethra.

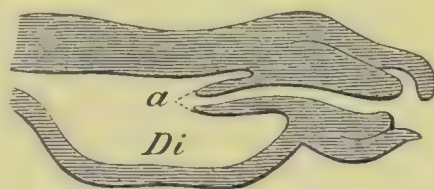


FIG. 559.—Diverticulum (*Di*) of the floor of the urethra: *a*, two tongued-shaped processes from the glandular urethra.

Treatment of Diverticula of the Urethra.—The following method has been used in the cases thus far observed, and with good success: A catheter is introduced, the whole length of the diverticulum is divided upon it, and any valves that are present excised. Enough skin and mucous membrane are cut away to make the urethra about the normal size. One should not remove too much skin, as it is desirable to obtain broad wound surfaces, which are united by exact suture. The edges of the mucous membrane are united with a continuous catgut suture, and the cutaneous wound is closed with lead-plate sutures and continuous catgut. A soft-rubber permanent catheter is introduced into the urethra.

Double Urethra.—A double urethra within the penis has, according to Kaufmann, never been reported from a reliable source. The cases that have

been described as such have been examined only imperfectly. Englisch has of late made a study of the cases of double urethra, congenital fistula of the penis, and abnormal canals which communicate at one end with the urethra. He has found three or four cases of double urethra leading into the bladder with a double penis. One sometimes finds besides the normal urethra a second canal on the dorsum of the penis which extends to the lower border of the symphysis. Luschka explains this as the excretory duct of an abnormally situated lobe of the prostate, and Klebs as a healed epispadias. Of other anomalies which have been erroneously regarded as a double urethra, Englisch mentions the canals which run parallel to the urethra and are separated from it by only a thin layer of tissue. This anomaly is regarded by Englisch as an abnormally dilated lacuna Morgagni.

§ 218. **Injuries of the Urethra.**—Injuries of the urethra include contusions, ruptures, incised wounds, lacerated wounds, punctured wounds, and gunshot wounds. Contusions occur most frequently in the bulbous and membranous portions when the penis or urethra is pressed by external violence against the lower border of the pubic arch. This accident may result from falling astride a picket, the branch of a tree, or an iron bar, or from striking the pommel of the saddle when riding, or from a blow, a kick, from being run over, etc. In the worst cases the penis is completely crushed. The skin is usually intact in contusions when the injury is not caused by a sharp-edged or pointed object. With a view to the extent of the extravasation of urine, it is of importance in subcutaneous ruptures of

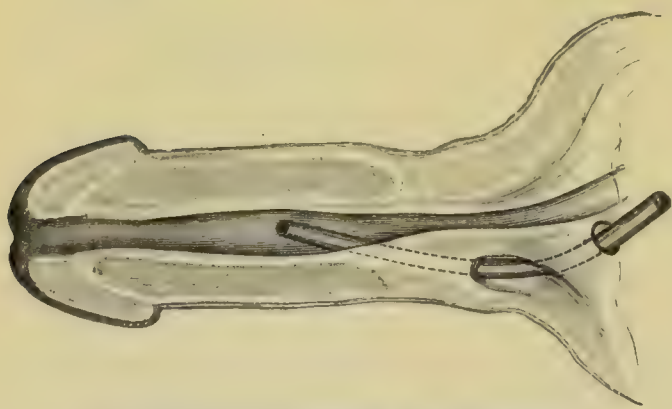


FIG. 560.—False passage (diagrammatic).

the urethra whether or not the deep perineal fascia is torn. Among injuries to vessels, rupture of the artery of the bulb may occur. Contusion of the perineal region is frequently complicated by splintering or complete fracture of the pubic arch.

Contused and lacerated wounds of the urethra may also take place from within, being due, for example, to foreign bodies or small pointed or angular calculi that have entered the urethra with the stream of urine. Lacerated wounds also include the so-called false passages which are caused by the careless introduction of catheters and bougies in case of stricture of the urethra. In this latter class of injury the mucous membrane is either injured only slightly, or there is a long wound channel in the surrounding connective tissue or in the prostate, running into the bladder or into the

rectum. Rupture of the urethra may also be caused by a fracture of the pelvis. Voillemier saw complete rupture of the bulb from forcible depression of the erect penis, with a fatal result on the twelfth day due to extravasation of urine, gangrene, and sepsis.

Gunshot wounds of the penis and urethra are, generally speaking, rare, and are usually complicated by serious injuries of adjacent organs.

Incised and punctured wounds are also very rare, and are the result usually of self-mutilation or criminal assault. Incised wounds of the urethra are most commonly caused by operative procedures.

The symptoms of a recent injury of the urethra consist mainly in a corresponding hæmorrhage, varying in amount between a few drops of blood causing a small clot to be expelled from the urethra, or a serious hæmorrhage that may persist for several days. It is of prime importance whether or not the evacuation of urine is prevented by the injury to the urethra. Retention of urine is present in about three fourths of all cases of rupture of the urethra, and is caused by separation of the ends of the urethra in complete division of the same, by blood clots within the urethra, by the pressure of a periurethral extravasation of blood upon the urethra, etc. Urination is often not interfered with immediately after the injury, and retention does not show itself until the next day, or even the third or fourth day. Swelling takes place mainly after contusion of the perineal region, but it also occurs after injuries of the pendulous urethra. An enormous swelling is sometimes found in the perinæum between the scrotum and rectum, in consequence of a very extensive extravasation of blood.

The further course of an injury to the urethra is most favourable in the case of a simple contusion without rupture of the urethra, which heals without causing any disturbances, just like any other subcutaneous contusion.

The outcome is very different when the urethra is ruptured, and particularly when it is completely divided. In such cases extravasation of urine is particularly to be feared, especially when the skin is intact, while with an open wound the urine can escape more easily. In large, open, incised wounds of the urethra, therefore, extravasation of urine does not usually take place. If, however, the escape of urine through the wound in the urethra and through the urethra itself is prevented, extravasation then takes place very quickly as soon as the patient tries to urinate. A diffuse swelling is formed at the site of injury which causes severe pain, and gives rise to a phlegmonous inflammation, sloughing, and fever, and the patient may die of sepsis within a few days if incisions are not made for the free escape of urine and pus. I recently saw a false passage result in a septic phlegmon

with gangrene, which spread very rapidly down to a point below the knees, and caused the death of the patient from sepsis in a few days. The farther posteriorly the injury takes place, the more dangerous the extravasation of urine. The most unfavourable regions for a phlegmon are, therefore, the perinæum and pelvic cellular tissue. Infection of the wound in the urethra by a non-aseptic catheter can also cause a severe septic phlegmon. In the mildest cases circumscribed abscesses are formed.

As regards extravasation of urine, it may be stated that the normal urine is aseptic, and in itself causes no damage. Stagnant urine, however, decomposes very quickly, and is easily infected by microbes. A large extravasation of clean aseptic urine can also cause necrosis of the tissues by pressure, and this hastens decomposition of urine and with it suppuration and gangrene.

Death may follow ruptures of the urethra in consequence of general sepsis due to extravasation of urine and a septic phlegmon, in case operative measures are not promptly resorted to. If recovery takes place, cicatrization of the wound in the urethra results in a stricture with all its symptoms (see § 222). Urinary fistulæ are particularly likely to follow suppurating and sloughing inflammations and open transverse ruptures of the entire urethra. The location of these urinary fistulæ is very variable: they occur on the penis, the scrotum, the perinæum, the thighs, the groin, in the vagina, rectum, etc.

The prognosis of ruptures of the urethra is good if a prompt outlet for the urine and secretions of the wound is provided for, if severe associated injuries are absent, and if the rules of antisepsis are strictly carried out. Kaufmann states that the mortality of this class of injury is 14·15 per cent. The prognosis of ruptures of the posterior urethra which are combined with fracture of the pelvis is the least favourable, because the fracture of the pelvic bones becomes compound in consequence of the wound in the urethra and the resulting extravasation of urine. This variety of injury has a mortality of forty per cent (Kaufmann). In such cases the patient is in imminent danger unless he comes under proper treatment immediately on receipt of the injury. Iversen states that out of seven cases of rupture of the membranous urethra posterior to the triangular ligament, six were complicated by fracture of the pelvis; and of these seven, six died.

Treatment of Injuries of the Urethra.—The principal indications are to relieve the retention of urine and prevent extravasation.

In case of retention, one should attempt to introduce an aseptic metallic or elastic catheter. If this is successful, the catheter may be left in the bladder and its end connected by means of a rubber tube with a bottle containing three-per-cent carbolic acid or 1-to-1,000 bichloride. The bottle may be placed between the patient's legs or outside the

bed. If it is impossible to introduce a catheter into the bladder and in this way relieve the retention of urine, one may either perform puncture of the bladder above the symphysis, or, better, external urethrotomy. The latter operation is always preferable to suprapubic puncture, because the wound in the urethra can be exposed and drained, and extravasation of urine prevented. When, however, the retention of urine is very marked, and one lacks proper assistance, it is a good plan to perform suprapubic puncture under local anæsthesia with ether spray or cocaine, and then subsequently, when the conditions are more favourable, proceed as soon as possible to external urethrotomy. The puncture wound in the bladder may also be of service in finding the proximal end of the urethra by retrograde catheterization (see page 306). In suitable cases one may suture the divided ends of the urethra with fine catgut, and in this way be more likely to obtain healing without a stricture. The cutaneous wound should be left open in order that extravasation may not take place in case the sutures in the urethra allow urine to escape. Any defects in the urethra may be restored by Wölfler's method of transplantation of mucous membrane, by plastic skin-flaps, by transplantation of the inner layer of the prepuce, etc.

In all cases of subcutaneous rupture of the urethra extravasation of urine and a phlegmon must be prevented by exposing the site of injury, particularly in ruptures of the posterior portion of the urethra. In the latter cases the injured portion of the urethra should, without exception, be exposed by perineal section, the escape of urine assured by the insertion of a permanent catheter or fixation of the proximal end of the urethra in the wound, and the latter packed with iodoform gauze, after arresting the hæmorrhage and removing any gangrenous tissue that may be present. The wound in the urethra may also be sutured in suitable cases.

If there is a fracture of the pelvis at the same time, which is made compound by the wound in the urethra, perineal section should likewise be performed and the wound disinfected and drained.

In gunshot wounds as well, the main indication besides the treatment of any associated injuries consists in exposure of the wound in the urethra and providing for an escape of the urine and secretions of the wound.

In case the rupture of the urethra is not fresh and a septic phlegmon is already present, free incisions must be made and the wounds drained. In such cases, particularly when the gangrenous destruction is very marked, permanent irrigation is to be recommended, or placing the patient in a permanent bath.

As regards the treatment of any complications, such as cystitis, urinary fistulæ, strictures, etc., the reader is referred to the corresponding paragraphs.

Cicatricial strictures of the urethra should, when possible, be excised (resection of the urethra). Partial resection of the urethra usually suffices in traumatic strictures, because, as Guyon pointed out, the upper wall of the urethra is usually intact. All periurethral structures must be carefully avoided in performing resection. De Paoli saw resection of the urethra followed by absence of erections. After partial resections or total resections, which involve the entire circumference of the urethra, a soft-rubber catheter is inserted and the urethra united over this with fine catgut sutures that include only the submucous layer. In total resections one must be careful that the ends of the urethra are sutured together without too much tension. The remaining soft parts and the skin are then united over the urethra by two or three rows of sutures. The catheter can often be removed in from two to four days.

Meusel excised a stricture resulting from an extensive laceration of the urethra and transplanted into the defect a flap from the inner layer of the prepuce five centimetres long and two and a half centimetres broad. The result was an excellent one. The defect resulting from the excision of such extensive traumatic strictures can also be filled in by Wölfler's method of transplanting mucous membrane—for example, from the vagina or rectum.

Cauterization of the urethral mucous membrane with nitrate of silver or other strong solutions may cause severe hæmorrhage, retention of urine, desquamation of portions of the membrane, and subsequent strictures. Strong solutions should consequently be condemned in the treatment of gonorrhœa, for example.

If cauterization of the urethra with nitrate of silver, for example, has already taken place, the bladder should be filled with salt solution by means of a soft-rubber catheter, and after removing the catheter the urethra irrigated with the fluid that flows out of the bladder. Weak astringent or disinfecting injections may be subsequently employed. In case of gangrene due to very severe cauterization external urethrotomy may be necessary.

§ 219. **Foreign Bodies in the Urethra.**—The most varied foreign bodies enter the urethra from without, especially pins, broken-off pieces of catheters, pieces of wood, silver-nitrate sticks, etc. Fragments of bone sometimes gain entrance to the urethra in consequence of fractures of the pelvis or inflammatory processes within the pelvis. The foreign bodies may either pass farther inward toward the bladder or be expelled with the stream of urine. Muscular contractions and erections of the penis may also push the foreign body farther backward.

Foreign bodies may also enter the urethra from the bladder, especially small vesical calculi and fragments of stone left behind after litholapaxy and lithotomy. These may remain lodged in the membra-

nous urethra, for example, or in the fossa navicularis. Urethral calculi originate less frequently in the urethra itself, and this is most likely to occur when a foreign body has remained in the urethra for some time. The urethral calculi that are formed within the urethra are almost always phosphatic stones; those made up of urates, oxalates, or cystin almost always come from the bladder or pelvis of the kidney. Not infrequently several stones are found in the urethra, and their number is sometimes very great. The size of urethral stones is very variable, and they have been found as large as a pigeon's egg or even larger, particularly in the prostatic urethra. Stones in the prostatic urethra and neck of the bladder sometimes project into the bladder, and are then shaped like a mushroom or an hour-glass. Large urethral stones cause considerable dilatation of the urethra. Like vesical calculi, urethral stones may lie in a diverticulum. Stones have also been found in urinary fistulæ—for example, in the scrotum and perinæum and in false passages.

The larvæ of insects have also been found in the urethra, as well as *strongyli*, which, as we saw above, may be present in the pelvis of the kidney, and wander down into the bladder and urethra and remain for a long time within the latter. Mould fungi—e. g., *Penicillium glaucum*—have also been met with in the urethra (Vincentini).

The symptoms resulting from foreign bodies in the urethra consist in a narrowing or complete occlusion of the same, so that the evacuation of urine is difficult or impossible. The larger, more pointed and dirtier the foreign body, the more marked the inflammatory reaction and the pain. Comparatively large urethral stones are sometimes remarkably well borne. I operated on a patient who for eight years had evacuated his urine with the aid of a catheter, supposedly on account of stricture of the urethra. I found a urethral stone in the prostatic urethra as large as a hazelnut.

The diagnosis of a foreign body in the urethra is usually made from the history, the group of symptoms present, and by exploration of the urethra with a metallic sound or stone-searcher. Large foreign bodies situated in the posterior urethra may also be felt through the rectum. The prognosis of foreign bodies in the urethra is good.

Treatment of Foreign Bodies in the Urethra.—Foreign bodies are extracted with instruments made for that purpose, such as the urethral forceps of Dittel, Colin, Mathieu, or Weiss, or the articulated curette of Leroy d'Etiolles, as modified by Charrière and Langenbeck (Fig. 561). These instruments are introduced when closed into the urethra as far as the foreign body. The curette devised by Leroy d'Etiolles (Fig. 561, *d*) is made to pass by the body, whereupon the instrument is

raised by means of an arrangement on the handle and brings out the body with it. One can also use a wire loop, a bent probe, or electromagnet. If a needle can not be extracted, it may be made to pierce the skin and then seized with dressing forceps. In all cases where extraction is difficult or impossible, external urethrotomy should be performed. If the body can be felt from the outside, one cuts down directly upon the same either with or without a guide, or after first introducing a grooved staff down to the body. If the body is in the deep urethra, median section should be performed. If the foreign body is in the fossa navicularis, the lower wall of the meatus is slit open if necessary.

Any complications, such as urethral abscesses, extravasation of urine, or retention, are treated in the usual way (see §§ 210–218).

§ 220. **Inflammation of the Urethra (Urethritis).**—Among inflammations of the urethra we shall first take up gonorrhœa, which is caused by a specific micro-organism (gonococcus) discovered by Neisser. Among the later researches regarding the nature of the gonococcus, those made by Bumm deserve special mention. Bumm's investigations remove all doubt as to the specific importance of Neisser's gonococcus.

The gonococcus is a fairly large, round bacterial cell, with a diameter of about 1.25 micromillimetres. One seldom finds single cocci, but they usually occur in pairs—i. e., in a condition of fission, in which both halves remain connected by a mucous envelope. They never appear in the form of chains, but always in scattered groups (Fig. 562, *a*). One frequently finds groups of four similar to groups of *Micrococcus tetragenus*. They are stained most readily with methyl violet or gentian violet and fuchsin; methylene blue stains them more slowly but more deeply. Very pretty microscopic pictures are obtained

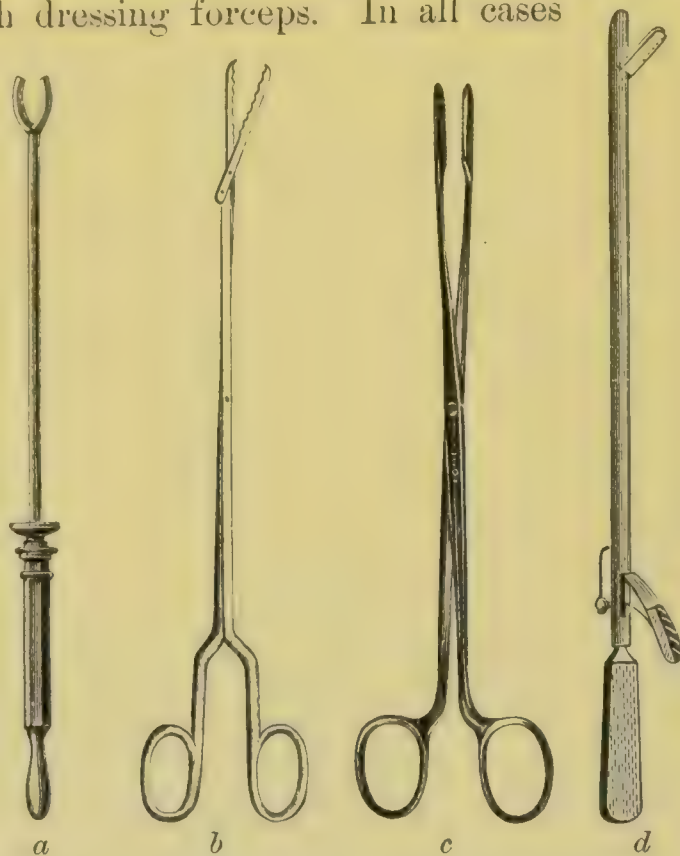


FIG. 561.—Urethral forceps for the removal of foreign bodies in the urethra: *a*, Dittel's; *b*, Colin's; *c*, Thompson's; *d*, d'Etiolles's articulated curette modified by Charrière and Langenbeck.

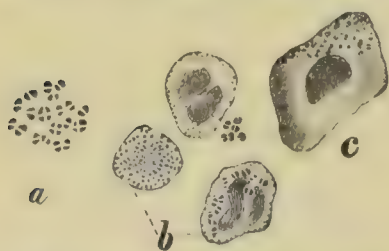


FIG. 562.—Neisser's gonococcus. $\times 800$ (Bumm): *a*, free cocci; *b*, cocci inclosed in pus cells; *c*, in an epithelial cell.

by use of a double stain with methylene blue and eosin. It is characteristic of gonococci to enter the pus cells and multiply here very rapidly (Fig. 562, *b*). One often finds pus cells filled with gonococci, or at other times groups of cocci which have the form of pus cells, while one can see nothing of the body of the cell. They are also to be found in epithelial cells (Fig. 562, *c*). According to Sinnety and Henneguy, gonococci are absent when the secretion is strongly acid.

Pure cultures of gonococci are not easily obtained; they grow best on blood-serum or blood-serum-gelatin at a temperature of from 30° to 37° C. Human blood-serum is better, according to Bumm, than animal. The pus used in making a culture should contain a large number of gonococci, but no other micro-organisms, as the former are easily overgrown. The surface of the gonococcus culture, which usually has numerous processes running out from it, is ordinarily as smooth as a mirror and covered with a grayish-white or grayish-yellow coating. The culture grows very slowly, advancing only from one to one and a half millimetres in twenty-four hours, and ceases to grow in from two to three days. It then begins to die, and in a few days its capability of further growth comes to an end. The propagative power of gonococci taken from pure cultures is destroyed by very weak antiseptic solutions. The cocci in gonorrhœal pus can be easily made to disappear by the use of solutions of bichloride (1 to 10,000), carbolic acid (1 to 400 to 200), nitrate of silver (1 to 400), acetate of lead (1 to 100), sulpho-carbolate of zinc, and the internal administration of balsam of copaiba. On the other hand, gonococci have been found in the urethra over a year after an apparent complete cure of a gonorrhœa. Bumm and Bockhart brought about gonorrhœa in man by the inoculation of pure cultures into the urethra. The process of gonorrhœal infection is, according to Bumm, the following: The cocci at first multiply very rapidly in the secretion, then invade the epithelial layer and spread between the epithelial cells into the papillæ. The invasion of the cocci comes to a halt in the superficial subepithelial layers of connective tissue, because here the nutritive conditions for the same are unfavourable. On the second day following the invasion by the cocci of the epithelial layer, a marked emigration of leucocytes takes place, by which the epithelial cells are forced apart or lifted *in toto* from the subjacent connective tissue. The regeneration of the epithelium starts from the remnants of epithelium left behind and takes place very quickly, beginning, according to Baumgarten, on the fourth day and ending on the tenth to the twelfth day. According to Bumm, regeneration does not take place so rapidly in the adult. Gonorrhœa is accordingly an inflammatory process that is confined to the surface of the mucous membrane. It can of course spread along the surface, and finally involve internal organs, such as the prostate, epididymis, testicle, uterus, and tubes. All deep suppurative inflammations, such as periurethral, prostatic, and testicular abscesses, suppurative buboes, etc., are, according to Bumm and Baumgarten, not the direct result of invasion with gonococci, but are caused by the presence of the *Staphylococcus pyogenes aureus*. The metastatic inflammations of joints are likewise usually caused by secondary infection with the *Staphylococcus pyogenes aureus* or other forms of pyogenic microbes. In some cases, however, gonococci are alone found in the fluid within the joint (Neisser).

It is of great interest that, as Bumm and Baumgarten pointed out, only mucous membranes with cylindrical epithelium or epithelium related to this are susceptible to gonorrhœal infection; hence it attacks the urethra, uterus, Bartholin's glands, the conjunctiva, but not the mucous membranes with squamous epithelium (oral cavity, lower portion of the nose, vagina of the adult). This fact is also of importance for the spontaneous cure of gonorrhœa, because, as Bumm showed, multiple layers of squamous epithelium are formed at the site of the gonococcus invasion in place of the epithelium that has been destroyed. In the majority of cases the gonococci are completely destroyed in a short time by the use of medicinal solutions. Metschnikoff attributes great importance to the phagocytes in the cure of gonorrhœa; the cocci are supposed to be taken up by the cells and rendered harmless. Metschnikoff's theory of phagocytosis has probably in reality nothing to do with the cure of gonorrhœa, but, on the contrary, the cells are eaten up by the victorious cocci. The latter invade the leucocytes and destroy them.

Besides the true gonococci, Bockhart has found in pseudo-gonorrhœal inflammation of the urethra and epididymis still other varieties of cocci which can be differentiated from true gonococci by their external form, their mode of growth, and their conditions of nutrition. Mechanical and chemical irritations of the urethra and conjunctiva can also cause a pseudo-gonorrhœal inflammation, with the formation of a non-specific, infectious secretion.

The microscopic changes in gonorrhœa have already been described above. The gross changes are as follows: The mucous membrane of the urethra is hyperæmic and swollen, and its secretion is at the outset thin and later more tenacious, purulent, and frequently mixed with blood. The mucous membrane becomes eroded, and may later be covered with deep ulcers. In consequence of its continuous extension, the gonorrhœa sometimes involves the prostate, Cowper's glands, the seminal vesicles, the vas deferens, the epididymis, the testicle, the bladder, the ureters, and the pelvis of the kidney. All suppurative complications (periurethral abscesses, buboes, prostatic and testicular abscesses, gonorrhœal rheumatism, etc.) are not caused by the gonococcus, but, as already emphasized above, by mixed infection with *Staphylococcus pyogenes aureus*. In infants gonorrhœa is often inoculated upon the conjunctiva during birth.

Acute gonorrhœa often passes into the chronic form, which varies very much in severity.

The clinical course of gonorrhœa follows from what has been said of its pathology and the nature of the gonococcus.

On the second or third day, more rarely on the fifth to the ninth, after infection, the patient experiences at first usually a feeling of itching or burning at the reddened meatus or in the glans itself. The meatus is agglutinated. The pain then increases, particularly on urination, the glans becomes swollen, and a more and more abundant serous, and later more tenacious, purulent secretion is discharged from the urethra. The patient suffers frequently from painful erections and emissions, particularly at night. In the later course the penis is some-

times distinctly bent (so-called chordee). These angular deformities of the penis are due to complicating inflammation of the corpus cavernosum. They usually disappear with the inflammation, but sometimes are permanent, when due, for example, to the cicatricial contraction of periurethral abscesses. The evacuation of urine may in acute gonorrhœa be seriously interfered with, and, in fact, swelling of the mucous membrane may in rare cases give rise to complete retention. A slight fever is usually present. Inflammatory swelling of the foreskin may give rise to phimosis—i. e., the swollen prepuce can not be retracted over the glans. In other cases the swollen foreskin becomes caught behind the corona glandis and can not be pushed forward (paraphimosis). Toward the end of the first week the inflammatory symptoms have usually reached their highest point, and in the second week, and particularly in the third week, the pain becomes less, the discharge diminishes and is more mucous in character. In the majority of cases which receive proper treatment recovery is complete.

In the malignant cases of gonorrhœa, particularly in those complicated by infection with *Staphylococcus pyogenes* or other pyogenic microbes, complications are sometimes observed, such as periurethral abscesses and inflammations of the prostate, Cowper's glands, seminal vesicles, vas deferens, epididymis, testicle, bladder, ureters, and pelvis of the kidney. Involvement of the seminal organs frequently causes sterility. Gonorrhœal rheumatism represents a metastatic inflammation of the joints, and is caused mainly by pus microbes. Albuminuria sometimes occurs in the acute stage of gonorrhœa, and is likewise the result of a systemic intoxication with pus cocci. Balser and Souplet found albuminuria 99 times in 424 cases. Cutaneous exanthemata have also been observed which are regarded by some as reflex neuroses. Suppurative pericarditis has occurred in rare instances. In consequence of these various complications, as well as of the strictures that may occur later, it is evident that gonorrhœa may in some instances become a serious disease.

For the symptomatology of the complications mentioned above the reader is referred to the surgery of the separate organs. Gonorrhœal rheumatism has been described in Principles of Surgery, page 662.

Acute gonorrhœa frequently passes into the chronic form, particularly when the patient does not take proper care of himself. Chronic gonorrhœa varies very much in severity. There is usually no pain and the discharge is generally slight, and appears particularly in the morning. Chronic gonorrhœa is most likely to be situated in the posterior urethra, in the bulbous urethra, in the prostatic urethra, and in Cowper's glands. The most important sequelæ of chronic gonorrhœa are the

strictures that gradually result from cicatricial contraction of the secondarily inflamed corpus cavernosum, particularly when a chronic gonorrhœa has been complicated by infection with pus microbes. The injection of too strong solutions and traumatism during catheterization, for instance, favour the formation of strictures. The duration of chronic gonorrhœa is very variable, and many patients have it for the rest of their life. It is a fact of great practical importance that men who previously had gonorrhœa and were apparently cured frequently infect their wives, and cause in the latter severe suppurative inflammation of the uterus and tubes. As shown by the statistics of gynæcologists, the number of women who become infected in this way is appallingly large.

For a description of gonorrhœa in the female see Surgery of the Female Generative Organs.

Gonorrhœa of the rectum is most frequent in women, and occurs either by direct infection from sodomy or by the passage of gonorrhœal pus into the rectum from the external genitals. Acute gonorrhœa of the rectum is characterized by swelling, hyperæmia of the mucous membrane, and severe pain. Chronic gonorrhœa of the rectum may lead to extensive ulceration, thickening of the mucous membrane, and stricture (see Surgery of the Rectum).

Treatment of Gonorrhœa.—The internal treatment of gonorrhœa is but slightly effectual, and consists in the administration of balsam of copaiba, turpentine, balsam of Tolu, balsam of Peru, oil of sandalwood, cubebs, etc. Balsam of copaiba is the drug most frequently given, and usually in the form of gelatin capsules, which contain about half a gramme. From three to eight grammes are given a day. The other above-mentioned balsams are given in the same way. Cubebs are given in powder form, in wafer form, or in capsules, as extract of cubebs with balsam of copaiba. The administration of these drugs sometimes produces a very marked effect, and in other cases the effect is completely absent. Generally speaking, internal treatment is applicable mainly during the acute stage, when the pain and inflammatory symptoms are marked and local treatment is not yet advisable. In my experience the internal treatment is at such times usually of great service in lessening the pain. One may also make use of internal treatment later on as an aid to the local treatment. The employment of the above-mentioned drugs has, unfortunately, its disadvantages when given for a considerable period of time and in large amounts. The principal disturbances are those of the digestive organs (loss of appetite, vomiting, and diarrhœa), of the kidneys (albuminuria and hæmaturia), and of the skin (urticaria and erythema).

The real treatment of gonorrhœa consists in the injection as soon as possible of antiseptic and astringent solutions by means of a suitable syringe. It was at one time the custom to wait until the disappearance of inflammatory manifestations before employing injections, but of late early injections have come more and more into favour. The so-called abortive method of treatment, consisting in the injection of strong solutions like two- to three-per-cent nitrate of silver, should be condemned, as it increases the inflammatory manifestations and favours the formation of strictures. The number of substances used for injections in gonorrhœa is very large. I mention particularly the following: I prefer for all stages of gonorrhœa liquor plumbi subacetatis dilutus, either with or without sulphate of zinc (200 parts liquor and $\frac{1}{2}$ to 1 part sulphate of zinc), or a five- to ten-per-cent solution of salicylate of sodium or two- to three-per-cent resorcin. In the declining stage I like subnitrate of bismuth (2 to 5 parts to 100 parts water). Among other solutions that have a wide use I mention bichloride of mercury (1 part bichloride to 10,000 or 20,000 parts water); sulphate of zinc or sulpho-carbolate of zinc (3 to 5 parts to 1,000 parts water); nitrate of silver (1 part to 2,000 or 3,000 parts water); permanganate of potash (2 to 4 parts to 10,000 parts water), for the acute stages, and tannic acid (2 to 3 parts to 1,000 parts water), sulphate of zinc, with acetate of lead (each 3 parts to 1,000 parts water), or acetate of lead (one per cent) alone, or finally acetate of zinc ($2\frac{1}{2}$ to 3 parts to 1,000 parts water) for the declining stages. A warm mixture of iodoform and glycerin (1 to 10), or ichthyol (one to two to three per cent), is also serviceable. The injections should not cause any pain, and the latter shows that the solutions are too strong. The injections are made with sterilized syringes of metal, hard rubber, or glass, with a conical or olive-shaped nozzle. They should be made two or three times a day at first, and then less and less frequently. Petersen recommends in place of the usual urethral syringe a syringe made like an irrigating syringe, consisting of a test-tube with its lower end drawn out and provided with an opening. To the end of this tube a piece of rubber tubing is attached with a short olive-shaped glass tube. This syringe allows the injection to be made with any desired pressure. The patient should be taught very exactly the method of injection, so that the syringe can be intrusted to him. Before making the injection the patient should urinate. The syringe, having been filled with the fluid, is introduced with the right hand into the meatus, the glans is pressed with the left hand against the syringe, and the contents of the syringe are then slowly forced into the urethra. The syringe is then removed and the meatus kept closed with the forefinger for from three to four

minutes. I allow the patient to inject only lukewarm solutions. The syringe should always be sterilized after use, and the patient should be warned of the danger of communicating the gonorrhœal poison to the conjunctiva by means of the hands. For this reason the penis should be kept as clean as possible by local baths, and the shirt kept from being soiled by inserting a piece of cotton under the foreskin or by means of a piece of linen made into the shape of an apron. Alcoholic drinks should be forbidden, a light diet ordered, and the patient kept as quiet as possible. To prevent painful erections, one may give one to two grammes of bromide of potassium or an injection of two- to three-per-cent cocaine. In case of retention of urine a lukewarm bath is serviceable, or a soft-rubber catheter may be introduced into the bladder. If the patient indulges in coitus too soon after recovery from gonorrhœa a recurrence may take place very easily.

For the treatment of complications on the part of the prostate, Cowper's glands, the bladder, the epididymis, the testicles, the rectum, etc., the reader is referred to the surgery of these organs. In gonorrhœa of the rectum one may employ sitz baths and astringent irrigations and insert a piece of cotton in the anal furrow.

Chronic gonorrhœa is often very hard to treat successfully. It is not rare for a gonorrhœa of long standing that has resisted all forms of treatment to heal up without any treatment. In every case of chronic gonorrhœa a careful examination of the urethra should be made with the electro-urethroscope of Nitze or Oberländer (see page 281), and then the treatment chosen to correspond with what is found. The same injections are used, generally speaking, in chronic gonorrhœa as in the acute form, but usually in more concentrated solutions. It is a very good plan to irrigate the urethra from the bladder several times a week. For this purpose the bladder is filled with an antiseptic solution, such as five-per-cent salicylate of sodium, three-per-cent boric acid, 1 : 500–1,000–2,000 nitrate of silver, or 1 : 10,000 bichloride, and then emptied by the patient. In this way the posterior urethra is irrigated, which is not the case with ordinary injections, as the latter reach only the bulbous portion.

If one does not succeed with injections, it is a good plan to make use of medicated bougies of iodoform, bismuth, tannin, or nitrate of silver, with butter of cacao. The silver-nitrate bougie is the most effective. I introduce the bougie as far as the posterior urethra, usually through a metal tube inserted into the urethra. Senftleben's "gonorrhœal pistol," consisting of a celluloid canula and a whalebone staff, or Dittel's applicator (Fig. 563), are also serviceable. The latter instrument is particularly useful for applying small quantities of a drug

to a certain portion of the urethra, such as an ulceration discovered by the endoscope. Dittel's instrument is introduced down to the inflam-

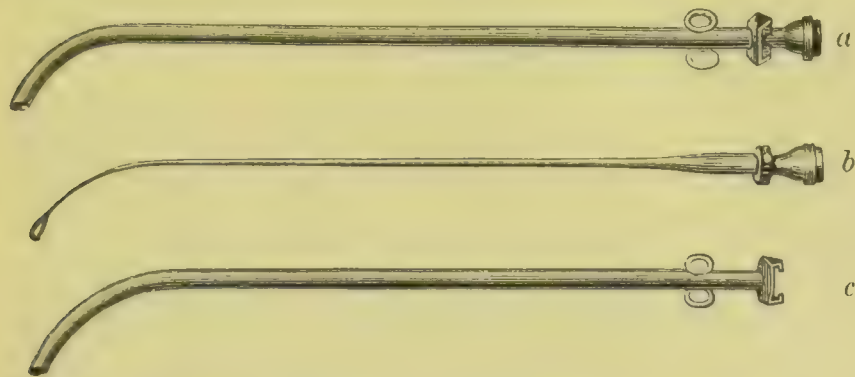


FIG. 563.—Dittel's applicator: *a*, the instrument consisting of staff (*b*) and canula (*c*).

matory focus, the obturating staff is withdrawn, and a portion of bougie about the size of a hemp seed (0.01 silver nitrate, or 0.015 oxide of zinc, or 0.03 alum to 0.20 to 0.25 butter of cacao) pushed by

means of the staff through the canula into the urethra. Garreau's *sonde à piston* and Lallemand's "caustic-carrier" work in the same way. Garreau's instrument also consists of a canula with obturating staff. In Lallemand's "caustic-carrier" the caustic is placed in the opening of the staff, the instrument is introduced into the urethra with the opening in its staff drawn back, and the latter is then pushed forward again so that the caustic can act upon the urethra. All these procedures should be employed at intervals of at least four or five days. Lesser recommends the injection of argemone ointment (argemone nitricum 0.2 to 0.4, pure lanolin 20.0) as used by Tameroli. This is injected either with a special syringe or Garreau's *sonde à piston*. The canula can be filled with the ointment by means of a hypodermic syringe after removal of the obturating staff, and by pushing in the piston the ointment can be brought in contact with any desired portion of the urethra. The application can be made every two or three days. The ointment continues to produce its action for a considerable time, and it is only at the end of twenty-four or forty-eight hours that the remains of it are evacuated with the urine. Antrophores are also employed in the treatment of gonorrhoea. In place of these, Dühring recommends "urethral spirals" — i. e., flexible

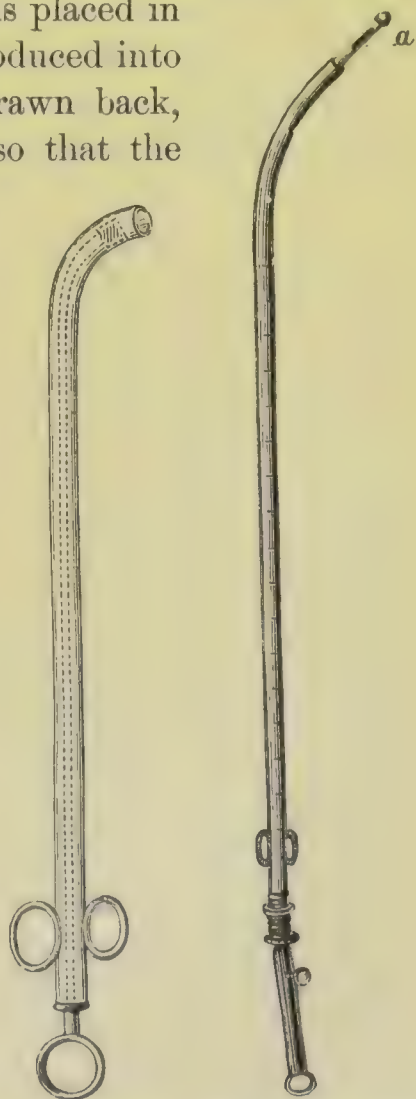


FIG. 564.—Garreau's *sonde à piston*.

FIG. 565.—Lallemand's caustic-carrier.

urethral bougies made of spiral turns of copper wire which are dipped in zinc glue, and in this way given a smooth surface. Before using they are covered with the ointment in question. Hamonic recommends for chronic gonorrhœa, and for chronic inflammations of the posterior urethra in general, the insufflation of vapours of iodine.

Another effectual form of treatment, particularly with beginning strictures, consists in the daily introduction of metallic sounds or large bougies. This methodical dilatation of the urethra is of great importance in chronic gonorrhœa. One can prevent in this way the formation of strictures from ulcerations and infiltrations in the urethral wall. Instruments which can be screwed up to any size have been employed for this purpose, but they are not so advisable as sounds. One should never forget the general condition of the patient in treating chronic gonorrhœa. Sea baths are often very useful in this particular.

§ 221. **Tumours of the Urethra.**—Among benign tumours, polyps and papillomata are the most frequent. Papillary growths or caruncles are particularly common in the neighbourhood of the external urethral orifice in women. The male urethra may also show such a marked tendency to papilloma formation that evacuation of the urine is interfered with. Dittel described a myxoma of the prostatic urethra in a boy ten years old who died of uræmia due to retention of urine. Primary carcinoma of the urethra is very rare; Rupprecht collected only seven cases from medical literature. Secondary carcinoma, due, for example, to the extension of a carcinoma of the prostate or bladder, is more common.

The symptoms caused by new growths of considerable size consist mainly in corresponding manifestations of stricture of the urethra. In carcinoma and other malignant tumours one finds destruction and phlegmonous infiltration of the urethra and its vicinity, followed, it may be, by the formation of fistulæ, particularly in the perinæum. Urination is very painful in the case of destructive neoplasms. Endoscopy is of great service in making the diagnosis of tumours of the urethra.

Treatment of Tumours of the Urethra.—Benign polypous growths are removed with the aid of the endoscope. In the case of larger polyps and other benign tumours the urethra is split open by performing external urethrotomy. Caruncles near the external meatus are removed with scissors and their pedicle destroyed with the galvano-cautery or thermo-cautery. In carcinoma and other malignant tumours amputation of the penis is often indicated, as it is only in case of an early diagnosis that it is possible to preserve the penis.

Tuberculosis of the Urethra.—Tuberculosis of the urethra is very rare, and is usually but one manifestation of an extensive tuberculosis of the genito-urinary system. It develops, as a rule, secondarily from the continuous extension of tubercular disease of the bladder or prostate, and hence occurs most frequently in the prostatic urethra and less often in the membranous portion. Primary urethral tuberculosis has, however, been observed in a number of cases. It is much more frequent in the male than in the female, only four cases having been known to occur in the latter. Anatomically, three varieties of urethral tuberculosis can be differentiated: (1) the miliary form, (2) the ulcerative form, and (3) the diphtheritic or caseous form. Langhans observed polypous granulations of tubercular origin. Englisch recently described a tubercular periurethritis which arises mainly in the prostate and seminal passages. The diagnosis of urethral tuberculosis is made from the detection of tubercle bacilli in the urethral discharge and from the endoscopic examination. The treatment is symptomatic, and is directed mainly against the primary tubercular focus. In suitable cases the tubercular area in the urethra may be exposed by external urethrotomy and treated according to general principles, depending upon what is found.

§ 222. **Strictures of the Urethra.**—By a stricture of the urethra in the ordinary sense we mean a narrowing of the canal caused by disease of its walls. We leave out of consideration the strictures of the urethra caused by foreign bodies, urethral calculi, tumours, and external pressure—for example, from an abscess.

Three main varieties of stricture can be distinguished—(1) spasmodic, (2) inflammatory, and (3) organic—caused by permanent tissue changes in the urethra and periurethral tissue.

1. Spasmodic strictures have not been generally accepted, but they do occur. Spasmodic strictures due to a localized spasm of the urethra are observed in inflammatory conditions of the urethra and adjacent organs, particularly the bladder and the rectum, in hypertrophy of the prostate, and in conditions of excitement and mental agitation in neurasthenia. Sudden retention of urine may occur at the same time. Spasmodic strictures may also accompany organic and inflammatory strictures. Temporary spasm of the urethra, particularly in the vicinity of the neck of the bladder, frequently occurs during catheterization, and for this reason an organic stricture is frequently diagnosticated when there is none present. Dittel, who has had a very large experience in genito-urinary diseases, is among those who hold the view that spasmodic stricture does occur, in very rare cases, in the form of an independent localized spasm of the urethra.

In all cases of spasmodic stricture a thorough examination of the urethra should be made with an endoscope to detect if possible any ulcerations of the urethra or other pathological changes.

The treatment of spasmodic strictures varies with their cause. In

case of neurasthenia this should receive the first treatment, and in addition one should use antispasmodic measures, such as the administration of bromide of potash, urethral injections of cocaine, warm baths, and narcotic suppositories in the rectum (0·05 morphine, or extractum opii 0·15, or extractum belladonnæ 0·05, to 1·5 butter of cacao). Morphine hypodermically is also useful. Any inflammatory conditions of the bladder and urethra should be treated according to general principles. In reflex-spasmodic strictures due to disease of the adjacent organs—hypertrophy of the prostate, hæmorrhoids, etc.—dilatation of the urethra or neck of the bladder by means, for example, of Voillemier's divulsor, is sometimes followed by remarkably good results (Le Dentu).

2. Inflammatory stricture is the result mainly of inflammatory swelling and œdema of the urethra, due, for example, to gonorrhœa, injuries, disease of the adjacent organs, etc. Here also the treatment is directed against the cause. The reader is referred, therefore, to the corresponding paragraphs, and particularly to the one on the treatment of acute and chronic gonorrhœa (page 354), and Injuries of the Urethra (§ 218, page 344).

3. Organic strictures are the most important and most frequent form of narrowing of the urethra, and result mainly from chronic inflammations and injuries of the urethra and from proliferation and cicatricial contraction of the submucous connective tissue. Narrowing of the urethra may also result from atrophy and absorption of the submucous connective tissue with distortion of the canal. Strictures sometimes result from the growth of tissue into the lumen of the urethra, as in tumours, and the formation of bands or folds. The location of organic strictures is very variable and is most frequently the membranous urethra.

The symptoms of organic stricture and of any narrowing of the urethra consist, first of all, in an alteration in the stream of urine; it becomes smaller, and, of course, more so the tighter the stricture. Every patient with a stricture requires more time than normal to evacuate his urine. The urine often comes away in drops. In consequence of this difficulty in voiding the urine the urethra becomes more or less dilated behind the stricture, and this is followed in the later stages by dilatation of the bladder, the ureters, and pelvis of the kidney. Tight strictures are very frequently accompanied by eccentric hypertrophy of the bladder—i. e., the same is dilated and its muscular coat is hypertrophied in consequence of the increased intravesical pressure and the greater muscular effort that the patient has to employ to overcome the obstacle made by the stricture. The diverticula of the bladder

which are found in patients with stricture and eccentric hypertrophy of the bladder are explained in the same way. In consequence of incomplete evacuation of urine the bladder may become filled more and more with urine, and the condition known as incontinence of retention may finally ensue (see § 209, page 302). Concentric hypertrophy of the bladder with diminution in its size also occurs, especially in the case of strictures in young individuals. Stricture patients frequently suffer from cystitis in consequence of ammoniacal decomposition of the stagnant urine, and especially in consequence of the frequent introduction of unsterilized catheters. This cystitis frequently leads to secondary inflammation of the ureters and the pelvis of the kidney, and in fact cystitis, with or without secondary pyelonephritis and nephritis, is one of the most frequent causes of death among patients with strictures. Among other sequelæ of strictures that may be mentioned are ulceration of the urethra behind the stricture, due, mainly, to the presence here of stagnant and decomposed urine which is full of micro-organisms; moreover, urinary abscesses, extravasation of urine, urinary fistulæ, etc. The inflammatory processes are also likely to spread to the vas deferens, the prostate, and Cowper's glands. Like the expulsion of urine, the emission of seminal fluid is difficult and painful. Tight strictures may suddenly give rise to acute retention of urine; the stricture becomes impassable, and the retention has to be relieved by suprapubic puncture of the bladder, or better by external urethrotomy.

Prognosis and Diagnosis of Strictures of the Urethra.—The prognosis of every stricture is almost always a matter of doubt. Every organic narrowing of the urethral canal due to inflammatory processes and traumatism usually goes from bad to worse and carries with it the serious dangers enumerated above. Extensive fibrous strictures can not be radically cured either by dilatation or operation. Such strictures can no doubt be improved, but the patients have to be kept under observation, and are obliged to have sounds passed from time to time. The treatment of patients with stricture is particularly difficult when, in consequence of careless catheterization, a false passage has been made. The diagnosis of a stricture is made mainly upon examination of the urethra with sounds and bougies, and in some instances with the endoscope. Extensive fibrous strictures can be easily felt from the outside. Exploration with sounds and bougies also shows whether and to what extent a stricture is passable.

Treatment of Strictures.—We shall occupy ourselves here mainly with the treatment of organic or fibrous strictures due to proliferation of connective tissue and cicatricial contraction following inflammation and traumatism of the urethra. The treatment of these organic strictures depends upon whether they are passable or not.

The treatment of organic strictures consists, in a word, in dilatation

of the contracted portion of the urethra and in the removal, as far as possible, of the newly formed periurethral connective tissue in order that the stricture may not return. The latter task is, however, combined with great difficulties. Dilatation of the stricture is accomplished either by the introduction of sounds or bougies or by external or internal urethrotomy.

The gradual dilatation of a stricture is brought about by the passage of sounds or bougies corresponding in size to that of the stricture. After their introduction the instruments are kept in the urethra for from five to twenty minutes, or still longer. This procedure is performed either daily or once or twice a week—depending on the case—and one tries to pass gradually larger bougies or sounds through the stricture until the caliber of the urethra has become normal. In every examination and dilatation of a stricture one must be careful to use instruments that have been carefully sterilized. Another method of dilatation which is of good service, particularly in long strictures, is the so-called “tunnelling,” in which one passes a large-sized sound into the commencement of the stricture, and then at every subsequent sitting tries to force his way farther into the stricture until the same is finally dilated throughout its whole length. Thompson in particular has recommended that elastic bougies should be introduced as far as possible into the stricture and left there for two or three days. At the next sitting one tries to pass a larger size into the stricture. In order that the bougies may be better borne by the patient, they should not be introduced into the bladder, but only as far as the neck of the bladder. This method is often successful in a surprisingly short time. At the end of eight or ten days one can usually give up the permanent insertion of elastic bougies, and then proceed in the usual way with the passage of sounds.

Still another form of dilatation of a stricture is the forcible dilatation of the same, in which different-sized sounds or special dilators are forced through the stricture at one sitting, usually under chloroform. This procedure always carries with it certain dangers, and, generally speaking, is to be condemned. I am also no friend of forcible dilatation with special instruments (see page 364). In long and tight fibrous strictures, and when there is adhesion between the fibrous tissue and the symphysis, I consider forcible dilatation absolutely contra-indicated.

The instruments used in the dilatation of strictures are metallic sounds, elastic bougies, wax bougies, strands of catgut, and specially-constructed dilators. Every instrument should, before using, be thoroughly sterilized and smeared with two- to three-per-cent boroglyceride in order that it may glide along the urethra more easily. It is also a good plan to inject sterilized

oil down to the stricture, because the oil is then at the site of stricture where it is most needed.

1. The sounds used are conical, cylindrical, or bulb-pointed, are made of silver, alpaca, tin, lead, or steel, and have a long or short curve. Metallic sounds are preferable to flexible instruments for the dilatation of strictures, as they are much more effective, durable, of an agreeable weight, and can be perfectly sterilized by

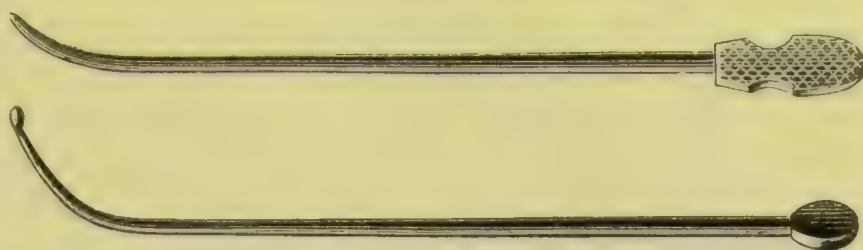


FIG. 566.—A probe-pointed and a slightly conical metallic sound for the dilatation of strictures.

placing them in boiling water. Béniqué's sound, made of tin (Fig. 567), has a special curve which permits its being left in the urethra for a considerable time without causing the patient any discomfort.



FIG. 567.—Béniqué's tin sound.

2. The soft, flexible bougies which are in very general use, are agreeable to the patient, and are in fact indispensable in the treatment of strictures. Depending on the shape of its end, a bougie may be cylindrical, bulb-pointed, conical, and spindle-shaped (Fig. 568). We have already described the different forms of bougies (page 275). We also stated there that a soft catheter could be made stiff by the insertion of a stylet.

Tedeski's sound, the composition of which is a secret, forms a transition to the rigid metal sounds. Leiter made a similar sound of drawn-out tin. I do not like these semi-elastic sounds.

3. Of wax bougies the English varieties are the best; they are softer and more pliable than catgut, but the smallest sizes can not be used because they are too soft. The tip of a wax bougie is easily bent, but does not break off.

4. Catgut is useful in very tight strictures. It swells in consequence of its capillarity, and in this way dilates the stricture.

A soft filiform bougie can also be used in combination with a metallic catheter or sound (Fig. 569). The filiform bougie is armed with a screw tip, by means of which it can be adjusted to a catheter or sound. The bougie is first introduced into the urethra, the sound or catheter screwed into its tip, and the end of the sound then passed into the stricture. The sound can not make a false passage, because, in the first place, its tip is not free, and, secondly, its path is prescribed by the bougie, which acts as a guide.

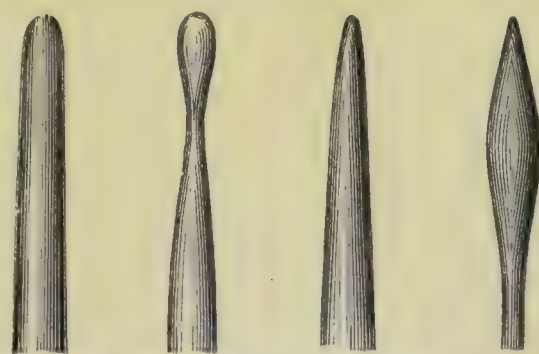


FIG. 568.—Cylindrical, bulb-pointed, conical, and spindle-shaped bougies.

For the forcible dilatation of strictures, special dilators in great numbers

have been recommended. These instruments usually consist of two halves, which can be separated from one another by a special form of mechanism at

the handle, so that in this way the stricture is dilated. Fig. 570. shows the dilators of Stearns (*a*), and Holt (*b*), the first with open blades. I consider these dilators in some cases unnecessary, and in others even dangerous.

The treatment of strictures by electrolysis has been recommended particularly by Frommhold, Malley, Newman, Jardin, Fort, and others. Newman in particular obtained very good results in a large number of cases by this method of treatment. Pasquier recommends an instrument for this purpose which looks like a small riding-whip, at the centre of which a small platinum blade is attached. The current is transmitted to the blade by means of a thin metallic shaft. The latter is inclosed in a gutta-percha covering, which is prolonged beyond the blade as a filiform bougie. The latter is passed through the stricture; as soon as the platinum blade is caught in the stricture the current is closed, the negative pole is connected with the instrument, and the positive pole is placed upon the thigh or the abdomen.



FIG. 569.—A filiform bougie attached to a metallic sound (*a*) and a metallic catheter (*b*).

The blade is pressed against the stricture and finally passes through it. Only one *séance* is necessary, but this may last for from one half to three quarters of an hour. It is painless and there is no hæmorrhage. J. A. Fort uses an instrument which is similar to Maisonneuve's urethrotome, and in place of a blade it has a blunt surface of platinum. This piece of platinum is connected, by means of a wire inside the instrument, with the negative pole of a battery of ten elements.

My treatment of strictures is briefly as follows: In every stricture which I examine for the first time I employ at the outset metallic sounds or catheters, beginning with the higher numbers and then going on to the lower ones, until one is reached which goes through the stricture. If unsuccessful with sounds or catheters, I then try elastic bougies or catheters, and, if the stricture is very tight, strands of catgut. I then give up the soft, elastic instruments as soon as possible and proceed with the metallic ones.

The treatment of strictures often requires much time and patience. One may try in vain for hours,

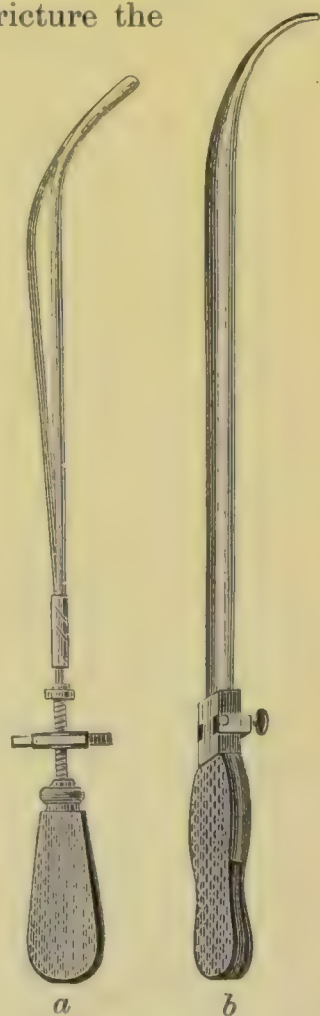


FIG. 570.—Dilators for the forcible dilatation of strictures: (*a*) Stearns's and (*b*) Holt's.

and yet the next day be able to pass the stricture at once. One should always proceed as carefully as possible in order to avoid injuries or false passages. The treatment may be particularly difficult in the case of fistulæ, false passages, firm adhesion of the fibrous tissue of the stricture with the symphysis, or oversensitiveness of the patient. Urethral fever not infrequently occurs in the course of treatment with sounds, and may be reflex in nature or the result of injury and infection of the urethra or bladder by dirty instruments. The treatment of strictures with sounds should always be combined with other measures, especially frequent warm baths, peat baths, and possibly massage, for the purpose of softening the stricture. Every patient should learn to pass a catheter or sound on himself in order that he may become independent of the physician. This may be, it is true, a source of danger.

If treatment of the stricture by dilatation with sounds or catheters is unsuccessful, if the stricture is impassable, if there is retention of urine, or a false passage with its sequelæ, the stricture will have to be treated by operation, usually internal or external urethrotomy (see below, § 223), or excision of the stricture with suture (urethrorrhaphy), as described on page 348. The treatment of defects in the urethra is also described there. Finally, in suitable cases of incurable stricture a permanent fistula may be formed in the perinæum (perineal urethrostomy, Poncet), or an artificial urethra may be made above the symphysis.

§ 223. **External and Internal Urethrotomy.**—External urethrotomy, or the so-called *boutonnière*, is performed for passable and impassable strictures, and for those that are complicated by fistulæ, abscesses, and false passages. The technique of external urethrotomy is essentially the same as that of median lithotomy. The patient is given the lithotomy position, and the perinæum is carefully shaved and disinfected. The operation is different, depending on the location of the stricture and whether or not it is passable. The skin incision is usually made in the posterior half of the rhaps. If the stricture is passable a grooved staff is usually passed through the same, and the skin and deeper tissues divided upon this. As soon as the groove in the staff can be distinctly felt through the lower wall of the urethra the nail tip of the left forefinger is placed in the groove and a pointed scalpel is made to pierce the urethral wall alongside the forefinger. The urethra is then divided, and with it the stricture. The cicatricial tissue composing the stricture is excised, and when possible the wound in the urethra should be closed over a soft-rubber catheter with fine catgut sutures (urethrorrhaphy, see page 348). The external wound is packed with iodoform gauze. A soft-rubber catheter should be left in the urethra for the next few days, whether the urethra has been sutured or not. Abscesses and false passages should be laid open. A long rubber tube is attached to

the end of the catheter at the meatus, and is connected with a bottle placed between the patient's legs or outside the bed. This is partially filled with 1-to-1,000 bichloride. For the methods of securing the catheter see page 278. Another good method of fastening the catheter is to tie a silk thread around the catheter in the wound and secure the ends over a piece of iodoform-gauze packing (Lauenstein). After healing has taken place the mucous membrane of the urethra is drawn by cicatricial contraction toward the outer skin, and to some extent prevents recurrence. The more extensive the stricture, however, and the more cicatricial tissue that has to be removed—i. e., the larger the defect—the more likely are recurrences to take place, and the more necessary is a periodic dilatation of the stricture by means of metallic sounds after the operation. Urinary fistulæ sometimes persist after healing has taken place, which usually close promptly by cauterization with the nitrate-of-silver stick, or with the galvano-cautery or thermo-cautery.

If the stricture is impassable the grooved staff can only be introduced down to the stricture, and the difficulty then consists in finding the proximal end of the urethra. Generally speaking, the best plan is to open the urethra in front of the stricture and then try and find the urethral canal in the stricture, whereupon the latter is divided. The proximal end can also be found in some instances by pressing on the bladder or having the patient urinate. One may also, in suitable cases, look for the urethra behind the stricture, open it, and then determine its course from behind with a probe or bougie. For a description of posterior catheterization, see page 306. After completion of the operation a soft-rubber permanent catheter is passed from the meatus into the bladder.

Internal urethrotomy—i. e., division of the stricture from within the urethra—is adapted only to the cases where the urethra is narrowed by short bands or rings. It is seldom employed in Germany at the present time. It has its special dangers, because

it involves wounding the urethra. Of late, however, French surgeons, including Guyon, Pousson, and others, have again recommended internal urethrotomy very highly, and have had good results. The opera-

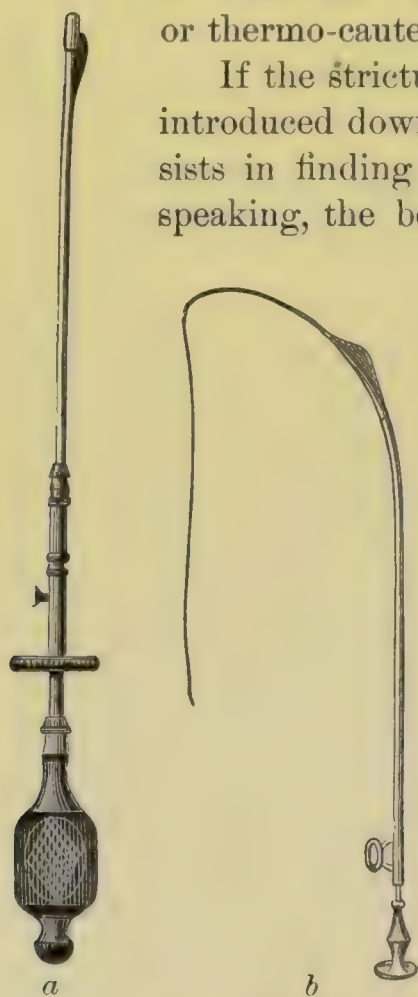


FIG. 571.—Urethrotomes: (a) Civiale's and (b) Maisonneuve's.

tion is performed with ingenious instruments possessing a concealed knife. The urethrotome is passed through the stricture; the blade of the knife is then made to project by a special mechanism and the instrument withdrawn, thus cutting through the stricture. Among the great number of urethrotomes those devised by Civiale (*a*) and Maisonneuve (*b*) are shown in Fig. 571. The Otis urethrotome is also a very useful instrument. In order to prevent serious hæmorrhage and extravasation of urine the stricture should always be divided on its upper surface, and exactly in the median line of the penis. Two or three days later the passage of sounds should be begun as described above.

For the technique of puncture of the bladder in retention of urine see § 210.

§ 224. **Urethral Fistulæ.**—A urethral fistula is an abnormal communication between the interior of the urethra and the external air, which discharges urine and is caused by inflammatory and other destructive processes of the urethra and its vicinity, by foreign bodies, etc. Depending on the location of the fistula one speaks of penile fistulæ, scrotal fistulæ, perineal fistulæ, urethro-rectal fistulæ, etc. If the mucous membrane of the urethra has grown together with the outer skin, such a fistula is called a “labiform fistula” (Roser). The amount of urine that escapes through the fistula is very variable.

The diagnosis of urethral fistulæ is very easy if the fistula can be seen and discharges a large amount of urine. In doubtful cases, particularly in narrow, forked fistulæ—for example, one communicating with the rectum—it is a good plan to inject a coloured fluid into the bladder and then make the patient urinate. In urethro-rectal fistulæ a metallic catheter may be introduced into the bladder and a probe then passed into the fistula within the rectum, the sphincter being dilated if necessary, in order to determine whether the probe and metallic catheter come in contact.

Treatment of Urethral Fistulæ.—One should first of all determine the underlying cause of the fistula. If, for example, there is a stricture this should receive the first treatment, and, upon dilatation of the stricture, the fistula often heals very quickly of itself, or after cauterization with the thermo-cautery or galvano-cautery. Fistulæ with fungous granulations usually have to be divided and energetically scraped out, and then a permanent soft-rubber catheter introduced into the bladder or the urine evacuated with the catheter at regular intervals. In cicatricial and labiform fistulæ the cicatricial tissue and the mucous lining of the fistula have to be removed by splitting it open and freshening its sides. It is then allowed to heal by granulation, or is sutured in the way to be described for urethral fistulæ in the female.

When possible, the fistula should be freshened and closed by sutures which pass through only the submucosa; the line of suture is then covered over with subcutaneous cellular tissue and skin (urethrorrhaphy). In large fistulæ and defects the loss of substance should be replaced by a plastic operation (urethroplasty), pedunculated skin-flaps being taken from the vicinity of the fistula, such as the skin of the penis, the perinæum, the scrotum, the abdominal wall, etc. Urethroplasty is often unsuccessful because the erections interfere with the healing of the flaps. To prevent erections, bromide of potassium and narcotics are given in large doses.

In urethro-rectal and vesico-rectal fistulæ the sphincter should be stretched under an anæsthetic or the posterior rhapshe divided in order to gain access to the fistula. The latter is then freshened and closed by suture in the way to be described for vesico-vaginal fistulæ (§ 256). In the case of fistulæ in the vicinity of the sphincter, it is usually sufficient simply to divide and scrape out the fistulous tract, which is then allowed to heal by granulation.

§ 225. **Congenital and Acquired Deformities of the Penis.**—Complete absence of the penis with normal development of the testes is very rare. Kaufmann mentions three cases. The occurrence of a double penis is also rare, and is confined usually to children with three lower extremities or other similar deformity. Kaufmann states that three such cases have been described in medical literature. I saw a case of double penis in a child otherwise normal.

Rudimentary development of the penis occurs especially in epispadias and hypospadias (see § 217, pages 333–339). Dumreicher described a case of partial absence of the corpora cavernosa penis.

Förster, Klebs, and others have described a complete congenital fissure of the penis.

Congenital fistulæ of the penis are very rare. They have been found on the dorsum of the penis, directly behind the glans, or in the posterior third of the penis near the pubic hairs. These fistulæ usually run along the middle line of the dorsum of the penis subcutaneously, and in front of the pubic arch pass in more deeply into the prostate, for example (Luschka). Girardet, Machet, Verneuil, and Pribram have described similar cases. Klebs thinks that congenital fistulæ of the penis are due to the healing of an epispadias during foetal life.

Phimosis.—The anomalies of the prepuce have a particular importance, especially congenital narrowness of the preputial opening, or phimosis, in which the prepuce can not be retracted over the glans. Adhesions between the prepuce and the glans are physiological in the infant; separation takes place within the first half year, and is usually wholly completed in the eighth to the thirteenth year. It is important for the early and complete separation of the prepuce from

the glans that the preputial orifice should be large enough to allow the glans to pass through it, and, furthermore, that the two layers of the prepuce should be movable both on one another and on the glans. If these conditions are not fulfilled, the congenital phimosis persists and the prepuce can not be drawn back over the glans. In adults as well, the prepuce may be adherent to the glans. The degree of the phimosis is very variable. Besides this congenital phimosis, there is an acquired form due to inflammatory swelling of a normally wide and movable prepuce (inflammatory phimosis).

The symptoms and sequelæ of phimosis consist, in the infant and small children, in disturbances in urination, with corresponding symptoms. In consequence of the straining involved, the development of herniæ is favoured, and in consequence of the prevention of the free escape of urine, the distal portion of the prepuce becomes more and more ballooned out. If in such cases the prepuce becomes swollen by inflammatory processes, complete retention of urine may result. Enuresis may also be due to the existence of a phimosis.

In older boys and in adults difficulty in urination is only likely to occur in case of inflammatory swelling of the narrow foreskin. The most important symptoms due to phimosis in the adult consist in more or less disturbance of the sexual functions and in an increased disposition to traumatisms, inflammations, and infection. Erections and coitus are painful, tears in the narrow prepuce occur easily, and hence the frequency of infection with chancre in individuals with phimosis. Repeated attacks of balanitis are common on account of the impossibility of removing the smegma that collects under the prepuce. The smegma sometimes becomes thickened, and leads to the formation of concretions. The development of the organ is interfered with in extreme cases. Older men with phimosis are predisposed to cancer of the penis. Every patient on whom I have performed amputation of the penis for cancer had a phimosis. According to Althaus, phimosis also favours the occurrence of epilepsy and other nervous disorders. From what has been said, it follows that extreme phimosis may be a very serious affection, and great importance is to be attached to its proper treatment.

Circumcision as practised by the Jews in the form of a ritual is a thoroughly desirable operation. From a medical standpoint, however, it would be preferable to have the operation performed by physicians. Unpleasant sequelæ have not infrequently been known to result from ritual circumcisions, such as hæmorrhage, injury of the glans and urethra, erysipelas or transmission of tuberculosis, and syphilis when, for example, the wound is sucked by the officiating rabbi.

Treatment of Phimosis.—The physician should note in every newborn infant the size of the preputial orifice. If it is very small and the child has difficulty in passing urine, the phimosis should be operated upon just as in older persons. It often suffices in children to free with a probe the epithelial adhesions between the mucous layer and the glans, and then retract the prepuce forcibly over the glans. In older boys as well, the operation may be avoided by frequently retracting the prepuce. In very young children a dorsal incision is often sufficient, or one can perform a typical circumcision as in adults.

Operation for Phimosis.—There are two methods of operating for phimosis—viz., dorsal division of the prepuce with the formation of Roser's triangular flap, and circumcision—i. e., removal of the redundant prepuce, which may also be combined with the formation of Roser's triangular flap.

The dorsal division of the prepuce is made with the scissors, a pointed scalpel, or preferably a slightly curved tenotomy knife. The

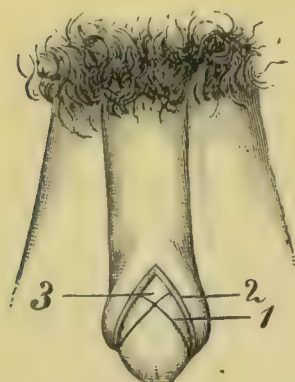


FIG. 572.—Roser's operation for phimosis: 1, inner layer of the prepuce; 2, cut edge of the outer layer; 3, triangular flap formed from the inner layer by two oblique incisions.

beginner should use a grooved director as a guide. When inserting the blade of the scissors or the tip of the knife beneath the prepuce, one should be sure that the scissors or knife have not entered the urethra. With the knife or tenotome the dorsal incision is made by piercing the foreskin behind and cutting forward and outward. After dorsal division of the prepuce the edges of the outer layer of the prepuce retract farther than those of the inner layer, and one sees that the narrowness was caused mainly by the inner layer (Fig. 572). The inner layer of the prepuce is now divided after Roser by two incisions running obliquely outward to the border of the glans, and the small triangular flap formed in this way is

turned back into the angle made by the outer layer and sutured in place. When necessary, one can trim off the sharp corners made by the incisions before uniting the two layers. If the prepuce is very long, one may trim away as much of its external and internal layer as is necessary—i. e., combine dorsal incision with circumcision.

Real circumcision is to be recommended for extremely long foreskins and for the excision of chancres on the distal portion of the prepuce. The latter is seized between the blades of a clamp or a pair of thumb forceps, and the projecting portion is cut away. Both layers of the prepuce are then divided on the dorsum for a short distance, and then the inner layer as far as the corona, the cut edges are rounded

off, or Roser's flap made. The latter is, however, in most cases neither necessary nor desirable. For suture material I use fine silk in adults and catgut in children. I almost invariably employ the latter method of operating.

Acquired Phimosis.—Inflammatory swelling of the prepuce due to gonorrhœa, chancre, etc., gives rise to so-called inflammatory phimosis. Phimosis may also be caused by chronic œdema and swelling, or cicatricial stenosis. Inflammatory phimosis is treated in the same way as the congenital variety, and operation is particularly important in the case of chancroidal ulcers on the mucous layer of the prepuce or on the glans. In inflammatory phimosis dorsal incision of the prepuce is usually employed with or without the formation of Roser's triangular flap, and with or without removal of the lateral portions of the prepuce.

Paraphimosis.—Paraphimosis is that condition of the penis in which the prepuce is retracted behind the corona and can not be brought forward over the glans. It is favoured by inflammatory swelling of a tight prepuce and by an abnormally long frenum. In inflammations—for example, of the mucous layer of the prepuce—the inner layer is everted and the outer layer pushed farther and farther backward. Paraphimosis frequently results from coitus in individuals with phimosis. In consequence of strangulation of the glans by the constricting ring of the prepuce behind the corona, circulatory disturbances take place both in the glans and the mucous layer of the prepuce. The glans becomes swollen in consequence of venous stasis, and that portion of the mucous layer of the prepuce which is under greatest tension, chiefly in the median line of the dorsal surface, may become gangrenous. This gangrene causes a break in the constricting ring of the prepuce, and in this way a spontaneous cure takes place with corresponding deformity of the prepuce. Gangrene of the glans occurs only in rare cases. Constrictions behind the corona in the form of hairs or threads wound about the penis may cause a similar swelling of the glans, and in every case of paraphimosis one should bear in mind the possibility of such a constriction of the glans.

The treatment of paraphimosis consists in prompt reduction of the retracted prepuce by manual taxis or incision of the strangulated ring of the prepuce. The first step in manual reduction consists in diminishing the size of the glans by careful kneading and massage or by applying an elastic bandage. The penis is then seized with the left hand behind the constricting ring of the prepuce, and the posterior portion of the glans is compressed with the thumb, index, and middle fingers of the right hand and pushed back through the preputial ring. If reduction is not accomplished in this way, or there is already circum-

scribed gangrene of the inner layer of the prepuce, the site of constriction on the dorsal surface of the penis is incised with a scalpel or scissors and the prepuce then pushed forward. In order to prevent recurrence the phimosis should, of course, be operated upon.

Preputial Concretions.—Preputial concretions usually occur in phimosis, and are formed by desiccation and calcification of the smegma or from deposits from the urine stagnating in the preputial sac. These concretions frequently have as a nucleus horny epithelial cells or gravel, or some foreign substance upon which urates and calcium phosphate are deposited. Some of the preputial concretions are not formed in the preputial sac, but are concretions from the bladder which escape from the urethra and remain lodged behind the phimotic prepuce. Preputial concretions are sometimes discharged spontaneously by causing ulceration and perforation of the skin. In horses especially preputial concretions may attain an enormous size.

Preputial concretions are best removed by circumcision, which should be performed with strict attention to antisepsis, since the decomposed secretion beneath the prepuce has been known to be the cause of erysipelas, sepsis, and even death.

§ 226. **Injuries of the Penis.**—**Wounds of the penis** in the form of punctured and incised wounds are rare. They occur mainly in the insane from self-mutilation, and sometimes are made by revengeful women during coitus. Complete removal of the penis and scrotum, or so-called emasculation, is customary in certain religious sects—in Russia, for example. In some tribes of Africa it is a war custom even to-day to cut off the penis of prisoners. The hæmorrhage caused by incised wounds of the penis is most severe when the organ is at the time in a condition of erection. Fatal hæmorrhage has, however, never been known to occur, as the bleeding usually stops of itself. Even very deep transverse cuts of the penis, involving two thirds of its diameter but leaving the corpus cavernosum urethræ intact, do not lead to gangrene if carefully sutured and suppuration is prevented.

Lacerated and contused wounds of the penis are more common. The most frequent injury is rupture of the frenum during coitus. More extensive lacerated and contused wounds of the penis are rarer, and are most likely to occur when the trousers or aprons of workmen are caught in machinery or in case of run-over accidents. The skin of the penis, and occasionally also of the scrotum, may be completely torn off, and after healing takes place cicatricial contraction of the defect results, causing a shortening of the penis, painful erections, etc. The loss of skin should be replaced as far as possible by plastic flaps, skin-grafts, etc.

Dislocation of the penis is another injury which may befall it, and consists in rupture of the attachment of the prepuce to the glans, with

subcutaneous displacement of the organ. This accident may occur from being run over, the shaft of the penis being displaced into the subcutaneous cellular tissue of the abdomen or the scrotum, and is recognisable here from the characteristic form of the glans. At the normal site of the penis there is only a loose, empty, ecchymotic sac.

In gunshot wounds of the penis there are usually severe associated injuries which form the chief symptoms.

Contused wounds also include the rare bites of the penis. Démarquay observed two cases in which the penis was bitten off by animals (horse and dog) close to its root.

Constrictions of the penis by threads, hairs, ribbons, rings, etc., deserve mention here. They occur in children or masturbators whose object has been to excite erections or prevent pollutions or enuresis. Circulatory disturbances follow, and even gangrene, particularly if the constricting body is broad. If hairs or fine threads are used, a deep groove is made in consequence of their cutting into the tissues, but no gangrene. I have seen in small children characteristic cases of constriction of the glans behind the corona with hairs. In every case there was a deep groove, and a temporary urinary fistula resulted. The local manifestations due to such constrictions are similar to those in paraphimosis. It is often not easy to find the constricting hair or thread. In making the diagnosis the groove that has been formed is of value. The treatment consists in removal of the constricting body.

The treatment of wounds of the penis follows general rules. In deep incised wounds the hæmorrhage should be arrested and the wound carefully sutured. In case the urethra is injured, the edges of the mucous membrane should be sutured with fine catgut and a soft-rubber catheter introduced. In punctured wounds it may be advisable to enlarge the wound in order to secure better drainage. Lacerated and contused wounds should be carefully disinfected, and the parts brought into apposition with tension sutures. In case of dislocation of the penis, the latter is best replaced by means of an aneurism needle, blunt hook, or dressing forceps introduced into the empty pouch. It is then secured in its normal place by suturing the border of the prepuce, which has been torn away, to its point of attachment behind the corona. Very large defects may have to be covered over with plastic skin-flaps from the vicinity of the root of the penis or the scrotum, or with skin-grafts. Kappeler made use of the uninjured inner layer of prepuce, which he turned backward after splitting it along the dorsum and separating the frenum.

In all severe injuries of the penis the latter should be kept elevated in order to prevent circulatory disturbances. This can be done by

means of a cushion between the legs, or a broad bandage fastened about the thighs.

For the treatment of injuries of the urethra see § 218.

Subcutaneous Injuries of the Penis.—Fracture of the penis consists in laceration of the corpora cavernosa, and is caused by a kick, bending or twisting the erect penis, and by coitus. Partial or complete rupture of the corpora cavernosa is characterized by severe pain and marked swelling, due to extravasation of blood beneath the intact skin, which usually becomes ecchymosed very quickly and over a considerable area. The tear is usually more or less oblique, and extends to a variable distance into the corpora cavernosa, or even involves the urethra. If the urethra is not injured the course is favourable, and healing takes place by absorption of the extravasated blood and the formation of a firm cicatrix in the corpora cavernosa. If, however, the urethra is injured, extensive inflammation and suppuration may result, with extravasation of urine, gangrene, and sepsis, unless suitable treatment is begun at once.

Laceration of the corpora cavernosa may cause loss of the power of erection in the cicatrix and in that portion of the corpora cavernosa situated in front of the cicatrix.

Contusions of the penis cause essentially the same symptoms as the above-described subcutaneous lacerations. The contusions confined to the skin of the penis are of course the most favourable.

The treatment of subcutaneous injuries of the penis consists in elevation of the organ on a cushion between the legs of the patient or on a wide bandage fastened about the thighs. The inflammatory swelling is reduced with liquor plumbi subacetatis and ice, and large extravasations of blood are treated by massage, compression, puncture, or incision.

§ 227. **Inflammatory Processes of the Penis.**—The most common inflammatory processes of the penis are acute inflammation of the surface of the glans (balanitis) and of the prepuce (posthitis). As both inflammations always occur in combination, they are designated as balanoposthitis. Three different forms of balanoposthitis are distinguished—viz., the catarrhal, croupous, and diphtheritic.

1. Catarrhal balanoposthitis is most commonly found in conjunction with phimosis, and is due to decomposition of the smegma and uncleanness. There is also a gonorrhœal form, due either to primary infection of the glans and prepuce or to secondary extension of gonorrhœal inflammation of the urethra. Balanoposthitis may also be associated with soft and hard chancres and other forms of ulceration.

The symptoms of acute catarrhal balanoposthitis consist in a red-

dening and swelling of the glans and prepuce, the secretion of a thin offensive mucus, especially in the coronal sulcus, and a feeling of itching and burning. Superficial erosions are frequently present. Lymphangitis of the penis may develop, with enlargement of the inguinal glands, which, however, seldom suppurate. Recurrences are frequent in case there is phimosis, and chronic forms are not rare in which the prepuce becomes thickened, the preputial orifice and meatus narrowed, and adhesions are formed between the glans and the mucous layer of the prepuce.

The treatment of catarrhal balanoposthitis requires in the first place correction of the phimosis. The remainder of the treatment consists in bathing the glans with liquor plumbi subacetatis dilutus or cold water and dusting its surface, and especially the coronal sulcus, with bismuth, oxide of zinc, amylum, or besmearing it with unguentum diachylon, and then using the powders. Erosions are most quickly healed by the light application of the nitrate-of-silver stick. Strictures of the meatus are remedied by incising the lower wall and suturing the mucous membrane to the skin. One may also make a Y-shaped incision and suture the triangular flap of skin or mucous membrane thus formed.

The very rare and contagious *balanitis erosiva circinata* described by Berdal, Bataille, and others attacks only patients with a very long prepuce, and is characterized by profuse suppuration. Cleanliness and the insertion of cotton bring about rapid healing.

2. Croupous or diphtheritic balanoposthitis is caused by the infection of wounds or ulcers (wound diphtheria), or may occur in conjunction with diphtheria of the fauces, scarlet fever, measles, smallpox, and other infectious diseases. The inflammation is characterized by the formation of a grayish-white diphtheritic coating. The course of the local disease is usually favourable, and healing of the superficial or deep losses of substance takes place quickly as soon as the pseudo-membrane has separated. The most important element is always the coexisting systemic disease.

The treatment of diphtheritic balanoposthitis consists in removal of the pseudo-membranes—with the thermo-cautery, for example—and in antiseptic treatment of the wound surfaces.

Balanoposthitis may in rare cases complicate diabetes (diabetic balanoposthitis). The patients complain of an itching and burning sensation; the mucous membrane is red and swollen and is covered with a muco-purulent, foul-smelling secretion and a croupous membrane. There are usually small multiple ulcerations present. The secretion contains numerous mould fungi which Simon and Friedreich consider characteristic of diabetic balanoposthitis.

Besides the local treatment, which is similar to that of catarrhal and diphtheritic balanoposthitis, an antidiabetic therapy is necessary. The circumcision of patients with diabetes was seldom performed in the pre-antiseptic days on account of frequent gangrene. In recent years, however, diabetic patients have been frequently operated upon, and healing has taken place without any reaction.

Herpes Progenitalis is characterized by the formation of groups of vesicles on the glans and prepuce, having at first clear and later turbid, purulent contents. The vesicles dry up and become scabs, or they form superficial erosions with a whitish covering, particularly on the inner layer of the prepuce. Confluence of the erosions may give rise to the formation of ulcers of considerable size. Herpes disappears, as a rule, in a few days. The patients complain of slight itching and burning. Cases are sometimes observed which are characterized by frequent relapses and nervous symptoms similar to herpes zoster ("neuralgic herpes").

Herpes progenitalis is easily differentiated from chancre, as the groups of small vesicles form only superficial ulcerations which heal quickly.

Treatment of Herpes Progenitalis.—The observance of cleanliness, bathing the parts frequently, and the application of bismuth, oxide of zinc, amylum, or unguentum diachylon will usually bring about rapid healing. In relapsing "neuralgic herpes" all treatment is usually unsuccessful (local treatment, hydrotherapy, quinine, iodide of potassium, arsenic, electricity). In case of phimosis, circumcision is advisable.

Phlegmon and Gangrene of the Penis.—Phlegmonous processes occur as a sequel to injuries and inflammations of the penis, and especially of the urethra, either in the form of circumscribed abscesses or a more diffuse phlegmon, especially after extravasation of urine. If the latter occurs, gangrene of very variable extent is likely to take place. Pus microbes may be transported along the lymph vessels (lymphangitis) and give rise to suppuration of the inguinal glands (lymphadenitis). Diabetic gangrene of the penis has been observed in a few instances.

Inflammation of the corpora cavernosa is most likely to occur after injuries and inflammations of the urethra in the form of periurethral abscesses or a diffuse phlegmon. After the abscesses have healed, or if there is a chronic cavernitis, circumscribed thickenings and hard infiltrations are formed in the corpora cavernosa. The penis then becomes correspondingly bent when in a state of erection (chordee), and coitus may be more or less difficult or painful.

Erysipelas following injuries of the penis has the same etiology as in other parts of the body, and sometimes leads to extensive gangrene and abscesses (see Principles of Surgery, § 71).

The treatment of the above-mentioned inflammatory processes follows general rules. A phlegmon should be incised as soon as possible, even though no pus can be made out. For the treatment of erysipelas, see Principles of Surgery, § 71. In case of chronic cavernitis with cir-

circumscribed thickenings of the corpora cavernosa, moist warmth, iodine ointment, and inunction of unguentum hydrargyri are beneficial.

§ 228. **Soft and Hard Chancre.**—The soft chancre (*ulcus molle*, chancreoid) is a local ulcer which is caused by infection with a probably distinct virus during coitus, and is complicated only by inflammation of the neighbouring lymph vessels and glands (*buboes*), but never leads to syphilis or other systemic infection. The hard chancre is the primary lesion of syphilitic infection. It is not the fact that the syphilitic chancre is harder than the chancreoid that makes the essential distinction between them, but rather the fundamentally different clinical course shown by the two varieties of infection. The soft chancre may also at times be more or less hard. This dualistic view, which sharply distinguishes between the soft and hard chancre in the way just described, is the one which is at the present time most generally accepted. This view is antagonistic to that of the unicists, who hold that the chancreoid can also lead to syphilis. The occurrence of mixed infections has probably been responsible in part for the failure of the dualistic view to gain general acceptance. In these mixed infections both forms of virus are inoculated; there is at first a soft chancre which gradually, corresponding to the longer period of incubation of the hard chancre, takes on a hard base and is then followed subsequently by the manifestations of syphilis.

The soft chancre, being conveyed as a rule from one individual to another through coitus, develops in man usually on the prepuce, the frenum, the glans, at the meatus, and more rarely in the urethra or on other parts of the body, as, for example, at the anus in consequence of sodomy, on the lip, tongue, or on the fingers in physicians and midwives. Inoculation of the virus is possible only when there is a break in the continuity of the skin at some point. The chancreoid is usually a more or less circular ulcer with abrupt, irregular, often undermined edges, and its floor covered with a yellow pseudo-membranous layer. Its secretion is abundant, and consists mainly of pus. It may be elevated above the surrounding plane (*ulcus elevatum*). Chancreoids are usually multiple, partly because several breaks in the skin have become infected at the same time and partly because chancreoidal pus is very infectious, and for this reason new ulcers are formed in the vicinity of the original lesion by autoinoculation, especially in persons who are uncleanly and neglect their disease. When the chancreoidal virus gets into a follicle of the skin it causes nodules like acne, with a very deep ulceration in the centre. This follicular chancreoid shows no tendency to spread along the surface.

After the floor of the ulcer has become cleaned, healing takes place

by cicatrization in the course of two, three, or more weeks. The duration of the active stage is usually not more than four or five weeks, and then granulation begins.

Phagedenic chancre is a special form which represents really a wound diphtheria of the chancre, runs its course with severe inflammatory manifestations, and has a tendency toward spreading gangrene. Phagedenic chancre may be due to a double infection with chancre virus and wound diphtheria, while in other cases the sloughing may be caused by constitutional anomalies, especially in drinkers, or by circulatory disturbances, particularly in persons who do not keep the diseased parts sufficiently clean.

The destruction of tissue occurring in phagedenic chancre may give rise to marked deformities of the penis, serious hæmorrhage in consequence of erosion of vessels, and the corpora cavernosa, and finally to septicæmia from the absorption of septic materials.

Serpiginous chancre is characterized by continuous extension of the ulceration and sloughing, while the parts first attacked heal up. This form of chancre may spread from the genitals to the skin of the mons veneris, the abdomen, the scrotum, the thighs, etc., forming a curved line of ulceration one or more finger-widths in breadth. In consequence of the long duration of the disease, which may be a matter of months or years, the nutrition of the patient suffers more and more. The etiology of serpiginous chancre, which is extremely rare, is still completely unknown.

The local inflammatory manifestations that occur in soft chancre give rise very frequently to inflammatory phimosis and paraphimosis.

Inflammation of the lymph vessels and lymph glands of the groin (bubo) is a very frequent complication of soft chancre. The nature of this inflammation is still a matter of dispute, but it is in all probability either a mixed infection with chancre virus and pus microbes, or a purely chancre infection. Spietschka found no micro-organisms in buboes, not even pus microbes. Involvement of the inguinal glands usually begins with acute inflammatory symptoms, such as swelling and reddening of the inguinal region, with fever. The superficial glands become infected at the outset, and later the deeper glands beneath the fascia. Resolution of the glandular swellings takes place in exceptional cases only, but they usually break down and form abscesses. If the pus is not promptly evacuated by an incision it breaks through either externally or into the surrounding tissues, and one often finds very extensive destruction of tissue and long fistulous tracts which not infrequently follow the large vessels or spread beneath the skin of the abdominal wall. In such cases the superficial and deeper

lymph glands are extensively diseased. The diagnosis of buboes offers no difficulties, and they can usually be distinguished without trouble from an inflamed omental hernia. Inflammation of an undescended testicle is the only condition that gives similar symptoms.

The micro-organisms of soft chancre are not fully known. Ferrari found small bacilli which are attached to the pus cells or lie within the same. De Luca cultivated from the secretion of two cases of soft chancre, besides *Staphylococcus pyogenes* and *Streptococcus*, still another variety of coccus, which when inoculated into human skin caused characteristic soft chancres which was not possible in the case of the other varieties of coccus. De Luca therefore regards this third coccus as the specific virus of soft chancre, and thinks that its activity is increased by the presence of the two pyogenic cocci. De Luca's conclusions have as yet not been verified. Recent investigations tend to show that certain bacilli first described by Ducroy are always found in chancroid, and that they are the only ones present in the inoculation ulcers of later generations; attempts at cultivation have thus far failed. It is characteristic of the virus of chancroid, as distinguished from that of syphilis, that it can be inoculated upon other parts of the body and invariably causes only a local ulcer, but never general syphilitic infection.

The chancroid which is caused by artificial inoculation with chancroidal pus develops in the following manner: In the first twelve to twenty-four hours—i. e., with no appreciable incubation as in syphilitic chancre—a red spot develops at the point of inoculation which on the second day changes into a nodule and on the third day into a small pustule. The latter dries up and forms a small scab, beneath which the characteristic chancroidal ulcer develops. The pus from this inoculation chancroid is then capable of being inoculated further, both upon the bearer and upon other individuals, and always gives rise to the same characteristic ulcer. The inoculation of a soft chancre is only possible in case there is a break in the continuity of the skin.

Treatment of Soft Chancre.—If the patient is seen within the first few days after infection it is a good plan to remove the ulcer by excision or cauterization with the galvano-cautery, the thermo-cautery, or the nitrate-of-silver stick. The latter is as a rule less advisable, because the ulcer is usually made larger. Excision of the chancroid is not always applicable on account of its multiplicity or its location. Further treatment consists in strict observance of cleanliness by bathing the ulcer frequently and applying small pieces of cotton dipped in weak astringent or antiseptic solutions, such as liquor plumbi sub-acetatis dilutus, carbolic acid (one per cent), zinc sulphate (one per cent), aluminium acetate (liq. alumini acetatis 15·0, distilled water 85·0), bichloride (1 to 5,000), glycerin, etc. A still better treatment is that with powders, especially bismuth, zinc oxide, iodoform, and iodol. Iodoform is the most efficacious, but is not liked on account of its penetrating odor. The latter can be concealed by means of coumarin, coffee, or safrol (oleum ligni sassafras). Ointments, such as boric oint-

ment, are, in my experience, of inferior worth. It is always essential that the ulcer should be properly exposed, and for this reason a phimosis should, if present, be treated by circumcision. A special diet is not necessary. It is important, however, that the patient should not exert himself too much, because this favours the development of a bubo.

The treatment of phagedenic chancreoid varies with the cause of the gangrene. If the latter is due to local circulatory disturbances, such as inflammatory phimosis or paraphimosis, these conditions should be treated as described on pages 369–371. If there is progressive death of tissue, the entire surface of the ulcer should be scraped with a sharp spoon, burned with the thermo-cautery, or cauterized with a solution of chloride of zinc (1 to 8). The ulcers are in other respects to be treated according to antiseptic principles, preferably with iodoform. Every patient with phagedenic chancreoid must be kept in bed, the penis elevated, etc. Hæmorrhages are stopped with styptics (*liquor ferri chloridi*), ice water, or compression.

The serpiginous chancreoid is treated in the same way as the phagedenic form—i. e., by the use of the sharp spoon, the thermo-cautery, or chloride of zinc. Thiersch has employed with success subcutaneous injections of silver nitrate (1 to 1,500) about the border of the ulcer. This is a very painful procedure, and should therefore be performed under an anæsthetic.

Treatment of Buboes.—Inflammatory swelling of the inguinal glands is treated at the outset by rest, ice, and cautious inunction of *unguentum hydrargyri*. If resolution is not accomplished in this way, or if suppuration has already taken place, an incision is made and the pus focus scraped out, or the enlarged glands removed. I always make a transverse incision parallel to Poupart's ligament, and, if necessary, add a longitudinal incision upward or downward, and then carefully dissect out the diseased glands. A longitudinal or a large cruciform incision may also be advisable. The ulcerated edges of the skin should be cut away, deeper glands looked for and removed if necessary, and long fistulous tracts split open. When numerous fistulæ are present the operation may become a very extensive one, as there are so many fistulous tracts to follow up. The wound is packed with iodoform gauze. In suitable cases healing may be hastened by secondary sutures.

For a description of hard chancre and syphilis the reader is referred to § 84, page 428, of the *Principles of Surgery*. The following brief statement of the differences between the two forms of chancre will suffice here: The inoculation of the syphilitic virus is followed at the outset by no demonstrable local manifestations. The duration of the

period of incubation varies usually from two to four weeks. At the end of this time there develops at the point of infection a characteristic induration of the tissues either in the form of a small firm papule the size of a pea, with a reddish surface or a flat infiltration as hard as cartilage, or, finally, a densely infiltrated area resembling a tumour. In case the virus of soft chancre is inoculated at the same time, a chaneroid develops at the end of the first or second twenty-four hours, and on top of this the characteristic syphilitic induration at the completion of the period of incubation of syphilis. The chaneroidal ulcer has often healed and the syphilitic initial lesion then appears in the cicatrix.

§ 229. **Tumours of the Penis.**—The most frequent new formations of the penis are the vegetations or warts found on the glans and prepuce which result from hypertrophy of the papillæ, with proliferation and enlargement of its vessels, and sometimes occur in great abundance. The confluence of single warts gives rise to the formation of large cauliflowerlike growths similar to a papillary carcinoma, the latter, however, being characterized by a hard infiltration of its base and a tendency to ulceration. Vegetations should be removed with curved scissors and forceps, the hæmorrhage being arrested by compression or cauterization with the galvano-cautery or thermo-cautery, which is also the best means of preventing recurrences.

Horny growths of the penis which are formed by hypertrophy and cornification of the epithelium that covers vegetations are very rare. Pick saw several horny growths develop in a man twenty-two years old after an operation for phimosis and removal of vegetations. One of these growths was 9·5 centimetres long, 3·5 centimetres in circumference at its base, and 2·5 centimetres at its tip. Horny growths sometimes develop into carcinoma, and hence their extirpation is always advisable. They are removed together with their base by cutting through sound tissue, and the hæmorrhage is arrested by suture, or, when on the glans, by compression or cauterization.

Sebaceous cysts of the penis are rare.

Carcinoma of the Penis.—Cancer of the glans and prepuce is most common in old men, but it sometimes occurs in persons between thirty and forty. Anatomically, it is usually an epithelioma which develops in the skin, and only rarely a carcinoma of the sebaceous glands (Waldeyer). The flat superficial epithelioma runs a more favourable course than the papillary carcinoma (Fig. 573), whose villous outgrowths are covered with a thick layer of epidermis and its base infiltrated. Cancer of the penis does not ulcerate in many cases until comparatively late, except the carcinoma granulosum (Waldeyer). It usually begins

as a warty elevation of the skin, and only rarely in the form of an ulcer. The corpora cavernosa are but rarely attacked, and then only in the later stages when the tumour has become very large. As a rule,



FIG. 573.—Papillary carcinoma of the penis in a man sixty years of age. Amputation of the penis and recovery.

only the regionary glands of the groin become swollen, further metastases being exceptional. Gussenbauer has called attention to the fact that, although visible enlargement of the inguinal glands may not occur until late in the disease, the microscope will show even at an early period cancerous infiltration of these glands. It is therefore advisable in operating on carcinoma of the penis to remove the inguinal glands at the same time, even though they may not appear to be diseased.

As regards the etiology of carcinoma of the penis, phimosis and the chronic irritation and inflammation that go with it play an important rôle. Demarquay states that out of fifty-nine cases there was phimosis in forty-two. According to Travers, carcinoma of the penis occurs among the Jews either not at all or very exceptionally. Other conditions besides phimosis that predispose to cancer of the penis are chronic inflammations of any sort, benign new growths (vegetations, horny growths), and cicatrices. Secondary carcinomatous nodules, in the corpora cavernosa, for example, develop in the course of a carcinoma of the bladder, prostate, and rectum.

The course of a carcinoma of the penis is the same as that of other cancers of the integument. The subjective disturbances are usually slight at the outset, and hence patients do not seek treatment until the disease is well advanced. It can be mistaken most easily for syphilitic lesions, particularly broad condylomata or broken-down gummata. The diagnosis can, however, usually be determined in doubtful cases from the history and the results of antisyphilitic treatment. Syphilitic growths and ulcerations usually heal within two to four weeks by the internal administration of potassium iodide, inunctions, etc. If one finds in an elderly individual in conjunction with phimosis a papillary growth with indurated base or ulceration, sloughing, and a foul discharge, the diagnosis of carcinoma can usually be made with certainty.

The prognosis of carcinoma of the penis is good if the inguinal glands are not affected at the time of operation. If, however, this is the case, recurrence takes place both in the stump and in the groin, particularly when several inguinal glands are diseased and adherent to the adjacent parts.

The treatment of carcinoma of the penis consists in excision of the growth or amputation of the penis, and thorough removal of the inguinal glands even when the latter are apparently not diseased. Depending upon the extent or location of the carcinoma, one may perform amputation of the penis in its continuity or complete extirpation of the organ. In the latter case it is a good plan to suture the stump of the membranous urethra into an incision in the perinæum in order that the patient may urinate more easily and not wet his clothing. For the technique of Amputation of the Penis see § 230.

Among other tumours of the penis, the different varieties of sarcoma are the most common—for example, fibrosarcoma, spindle-celled and round-celled sarcoma, angeiosarcoma, etc. Sarcomata of the penis may be either primary or secondary, following, for example, sarcoma of the testicle.

Cartilage and bone are formed in very rare cases in the corpora cavernosa, particularly in the fibrous coat and the septum (Lenhossék). This occurs only in elderly individuals, particularly those who have gout or syphilis. There is usually calcification, less frequently true ossification. Phleboliths seem to have some connection with these changes. These cartilaginous and bony formations give rise to chordee, because the portions affected do not become distended during erection. Extirpation of cartilaginous and bony formations is easy and has repeatedly been resorted to with success.

Gummata of the penis are very rare. They usually form at the outset indolent nodules the size of a pea or bean which break down later and give rise to corresponding ulcers. Socin observed multiple gummata of the penis, scrotum, and left testicle. Broken-down gummata have, as already mentioned, great similarity to carcinomata, but the diagnosis of the former is determined by a successful antisymphilitic treatment, the microscopic examination of portions of tissue, and by the existence of other manifestations of syphilis.

The treatment is both local and constitutional (mercury, iodide of potassium; see Principles of Surgery, p. 433).

Tuberculosis of the penis is very rare, and occurs either in individuals who already have tubercular disease—for example, of the genito-urinary tract, or as a strictly local disease of the penis, including the glans. In such cases infection may have resulted from coitus. Löwenstein reported three cases of inoculated tuberculosis of the prepuce caused by the Jewish custom of sucking the wound after circumcision. For a description of tuberculosis of the urethra see page 359. The treatment of tuberculosis of the penis is operative (excision, thermo-cautery, possibly amputation of the penis).

Leucoplakia sometimes occurs on the mucous surface of the prepuce in the form of a thick, white coating, as on the mucous membrane of the oral cavity. This should be removed at once by operation, as it may develop into carcinoma.

Elephantiasis of the penis is very rare, even in those countries like India where the disease is endemic. It is either confined to the prepuce or, what is more common, involves the whole organ. Enormous hypertrophy of the prepuce and penis may occur, particularly when the scrotum is involved at the same time. In such cases the prepuce may hang down as far as the knees. The location of the disease—i. e., the hyperplasia—is in the skin, the subcutaneous cellular tissue, and the lymphatics. Elephantiasis occurs in two forms, in one of which it is caused by various chronic inflammations, erysipelas, lymphangitis, and injuries of nerves. The second form is a disease whose nature is still unknown, which is endemic in tropical and sub-tropical countries (Central America, Arabia, India), and occurs only sporadically in Europe. The *Filaria sanguinis* has been found in a few cases in the dilated lymphatics of the epidemic form (Lewis).

The treatment of elephantiasis of the prepuce and penis consists in removal of the diseased foreskin and excision of spindle-shaped pieces of skin from the penis, followed by suture. In severer cases amputation of the penis is indicated.

Aneurisms of the dorsal artery of the penis sometimes occur after injuries. Varicose veins of the penis are, as a rule, small and of no clinical interest. The same is true of lymphangiectasiae due to various causes. The lymphangiectasiae found in elephantiasis are the most important.

§ 230. **Amputation of the Penis.**—Amputation of the penis is resorted to usually for carcinoma and sarcoma, and is performed on the pendulous portion of the organ by the use of a circular incision. The most essential features of the operation consist in suturing the urethral stump to the edges of the circular skin-flap, and in preventing cicatricial stricture of the urethral opening by dividing the latter longitudinally.

The operation is done as follows: The operator, standing on the patient's right side, grasps the penis near its root with the left hand, draws the skin backward toward the symphysis, and compresses the organ *in toto* in order to prevent hæmorrhage. An assistant draws the glans forward. In an amputation near the glans the organ is now divided transversely by a sawing movement of the knife. If one operates nearer the root of the penis, the upper half of the organ is cut through first and the rest later after the corpora cavernosa have been secured by a silk suture or a tenaculum to prevent the short stump of the penis from slipping back inside the skin of the scrotum. Both dorsal arteries of the penis are tied on the dorsum of the stump, while the arteries of the corpora cavernosa and the bulbo-urethral artery in the corpus spongiosum should be secured by a deep suture. The lower wall of the urethra is then slit open for about one centimetre to prevent cicatricial contraction of the orifice, and the edges of the mucous membrane are sutured to the skin above, below, and laterally. The

urine is evacuated with a catheter for the first few days. After amputation of the penis for carcinoma the inguinal glands should always be removed even though they are apparently normal (Gussenbauer).

Removal of the entire penis at its root has the disadvantage that when the patient subsequently urinates he always wets his clothes. To prevent this extremely unpleasant sequel one should make a urethral fistula in the perinæum (perineal urethrostomy). The urethral stump resulting from amputation of the penis is exposed by dividing the scrotum in the median line; it is then brought out through an incision in the perinæum and secured here with sutures. One can omit median division of the scrotum and simply expose the membranous portion of the urethra through the perinæum, open it, and suture it into the perineal wound. The anterior portion of the urethral stump can then be closed.

Amputation of the penis by use of the galvano-cautery has been performed of late by Bruns.

CHAPTER XXV.

INJURIES AND DISEASES OF THE SCROTUM, TESTICLE, EPIDIDYMIS, SPERMATIC CORD, AND SEMINAL VESICLES.

Injuries and inflammations of the scrotum.—(Edema of the scrotum.—Fistulæ.—Elephantiasis.—Tumours.—Injuries and diseases of the tunica vaginales of the testicle and cord.—Anatomical considerations.—Injuries (hæmatoma).—Acute and chronic inflammation of the tunica vaginales.—Hydrocele.—Hæmatocele, etc.—Tumours of the tunica vaginales and cord.—Deformities of the testicle.—Misplacements.—Undescended testicle (cryptorchismus).—Absence of the testicle.—Congenital atrophy and hypertrophy.—Injuries of the testicle and epididymis.—Acute and chronic inflammation of the testicle, epididymis, vas deferens, and spermatic cord.—Tuberculosis, syphilis, and leprosy of the testicle, epididymis, and vas deferens.—Neuralgia of the testicle.—Tumours.—Castration.—Injuries and diseases of the seminal vesicles.

§ 231. **Injuries and Diseases of the Scrotum.**—The scrotum is composed of the following layers: (1) Integument; (2) tunica dartos, which is made up of unstriped muscular fibres and elastic fibres, and is intimately connected with the skin; (3) tunica vaginalis communis, which is a continuation downward of the transversalis fascia; and (4) tunica vaginalis propria, which represents the lower unobliterated portion of the processus vaginalis peritonei (see page 212). The posterior portion of the testicle and the epididymis lie outside the sac of the tunica vaginalis propria, but are inclosed by the tunica vaginalis communis. The septum dividing the scrotal pouch into two halves is made up mainly of the tunica dartos, and corresponds in direction to the external rhaphe.

Among injuries of the scrotum the contusions should first be mentioned which are produced by a kick or blow, and give rise sometimes to very large effusions of blood beneath the skin or between the dartos and tunica vaginalis (hæmatoma of the scrotum), with a bluish-red discoloration of the skin. The course of such contusions of the scrotum is, as a rule, favourable, and even very large effusions of blood become quickly absorbed. It is only after extreme crushing of the skin, with gangrene of the same, that suppuration of the effusion need be feared.

The treatment of contusions consists in elevation of the scrotum and compression for aiding the absorption of the effusion. Very large effusions may be evacuated by an aseptic incision, in order to bring about more rapid healing. In case of gangrene of the skin one can either wait for the sloughing tissue to be cast off, or excise the gangrenous area, drain the wound, and suture it in part.

Of wounds of the scrotum, contused and lacerated wounds are the most frequent, incised and punctured wounds being less common. In time of war gunshot wounds of the scrotum are not rare. It is of importance for the course of a wound of the scrotum whether the tunica vaginalis is opened and the testicle prolapses, and whether complications arise from subsequent inflammation. Spontaneous healing in case of prolapse of the testicle can take place by granulation and cicatrization, which tend to draw the skin of the scrotum over the testicle, so that it gradually becomes inclosed.

Wounds of the scrotum are treated according to general antiseptic principles. If the testicle has prolapsed it should be thoroughly disinfected and replaced, and the wound drained and partially sutured. In old, already granulating prolapses of the testicle quicker healing can be obtained if one removes the granulations with a sharp spoon, makes the edges of the skin movable by dissecting them up from the subjacent tissues, replaces the disinfected testicle, and drains and sutures the wound. More extensive defects of the skin of the scrotum may have to be covered by plastic flaps taken from the inguinal region or thigh, or by skin-grafting. In bandaging wounds of the scrotum we may use a large protective dressing which surrounds the thighs and lower abdomen like a pair of tights, or simply a large suspensory bandage. A piece of rubber tissue is made to surround the penis, which protrudes through the dressing, in order that the deeper layers of dressing may not be wet with urine. The patient is made to urinate on his side, or a catheter is passed.

Phlegmon of the Scrotum.—Phlegmon of the scrotum often becomes complicated by gangrene of the skin and subcutaneous cellular tissue, and the inflammation also spreads readily to the abdominal wall. The most serious phlegmonous and sloughing inflammations are those following extravasation of urine due to rupture of the urethra.

Phlegmon of the scrotum should be treated as early as possible by multiple incisions, and the scrotum is elevated and covered with moist compresses. Dressings that exert pressure should be avoided. Phlegmon, erysipelas, and acute infectious diseases not infrequently give rise to gangrene, varying in extent. As soon as demarcation of the gangrene has taken place, the dead portions of the skin should be excised and the wound either sutured and drained, allowed to granulate, or covered with plastic skin-flaps.

Oedema of the scrotum occurs in dropsy and ascites, and is often excessive in amount. The best means of diminishing it is by multiple punctures with a pointed scalpel or a trocar.

Fistulae of the scrotum usually result from extravasation of urine following injuries, and perforating inflammations of the urethra (urinary fistulae). Pus fistulae of the scrotum develop from inflammations and abscesses of the testicle and epididymis, especially those of tubercular origin, and from gravitation abscesses, caused, for example, by buboes. Concretions sometimes enter the scrotum after perforation of the urethra (scrotal calculi).

The treatment of fistulae depends upon their cause (see also page 367, Urethral Fistulae). Fistulae that discharge pus should be slit open and scraped out, and, if possible, the underlying cause of the same removed, such as a tubercular testicle, a bubo, etc.

Elephantiasis of the Scrotum.—Hyperplasia of the scrotum, due to elephantiasis, gives rise to enormous enlargement of the same, especially in the

Orient and tropics, where the disease is endemic. Tumours reaching below the knee are occasionally observed, and in these cases the penis is entirely obliterated, the urine being evacuated through a slit-like opening in the sac. Elephantiasis is said to be particularly common in Samoa, where fifty per cent of adults are afflicted with the disease. It is characterized anatomically by hyperplasia of the skin and subcutaneous cellular tissue, by dilatation and new formation of vessels, particularly the lymphatics, and by hypertrophy of the nerve sheaths. In the so-called lymphangeiectatic form large lymph spaces and lymph cysts are formed. In some cases of true elephantiasis occurring in the tropics *Filaria sanguinis* has been found in the lymphatics. In the majority of cases, however, this parasite was not found.

The treatment of elephantiasis of the scrotum consists either in excis-



FIG. 574.—Elephantiasis in an inhabitant of Samoa. Removal of the scrotum weighing seventy-eight pounds; recovery (Königer).

ion of pieces of skin, followed by suture, or in severe cases in complete ablation of the tumour. If the latter operation is done, Turner's method of arresting haemorrhage should be followed. He recommends elevation of the scrotum for half an hour before the operation, whereupon a tourniquet is applied about the base of the tumour, after reduction of any hernia that may be present. A skin-flap about four centimetres in length is then marked out on the posterior surface of the tumour, and in front a long median flap for covering the penis, and finally a lateral flap on each side for covering the testicles. After the flaps have been formed the penis and testicle are dissected

out. The tumour is then ablated near the tourniquet and the blood-vessels are tied with from twenty to thirty ligatures, after loosening the tourniquet. The wound is irrigated with 1-to-1,000 bichloride, drained, sutured, and covered with an aseptic dressing, which includes the lower abdomen and thigh. A soft-rubber catheter is introduced into the urethra and a long piece of rubber tubing is attached to its distal end. The rubber tube is connected with a bottle placed between the patient's legs or outside the bed, which is partly filled with 1-to-1,000 bichloride.

Tumours of the Scrotum.—Of the various tumours of the scrotum, the fibroma and lipoma are the most common; they usually develop in the subcutaneous cellular tissue, spermatic cord, and tunica vaginalis propria, and can attain an enormous size. Sarcoma of the scrotum is rare, while chondroma and osteoma occur in exceptional cases. Among other tumours mention should be made of arterial and venous angiomas, lymphangiomas, and various kinds of cysts, particularly sebaceous and dermoid cysts. Teratomata, which are to be explained as an inclusion of foetal tissue, and the malformation known as *fœtus in fœtu*, also occur in the scrotum.

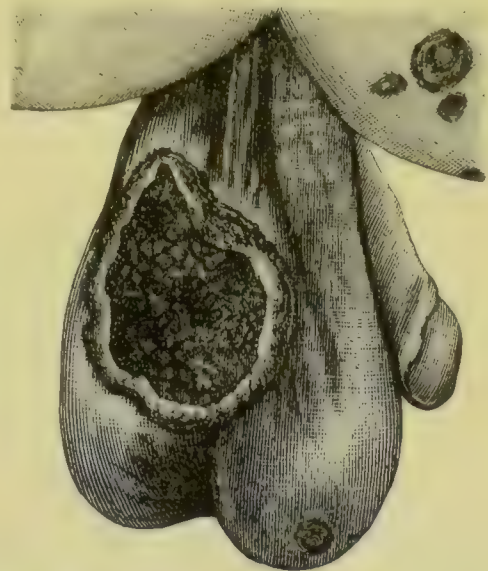


FIG. 575.—Epithelioma of the scrotum in a paraffine worker. Three ulcers covered with scabs can be seen on the right buttock.

Epithelioma of the scrotum is most commonly observed in chimney-sweeps and paraffine workers as a result of the irritative action of soot, tar, and paraffine. Their development is analogous to that of epithelioma of the tongue, lower lip, and interior of the mouth in smokers, because the same harmful substances are present in tobacco, soot, and tar, particularly carbolic acid. Fig. 575 shows an epithelioma of the scrotum in a paraffine worker that came under my observation. After extirpation of the epithelioma no recurrence took place in the scrotum, but a similar epithelioma developed two years later on the forearm, and, in spite of amputation, the patient died very quickly from internal metastases.

Chimney-sweeps' and paraffine cancer of the scrotum usually develops on top of a chronic dermatitis with excoriations, pustules, crusts, and warts. Generally speaking, the course of these forms of epithelioma is not unfavourable; the deeper tissues, including the testicle, remain intact for a long time, the nearest lymph glands do not become involved until late in the disease, and internal metastases are excep-

tional. According to Butlin, out of twenty-two cases of epithelioma of the scrotum that were operated upon, only nine died from recurrence.

The treatment of epitheliomata of the scrotum consists in prompt excision of the diseased area, and if necessary the testicle should be removed. Owing to the great extensibility of the skin of the scrotum, a large portion of the latter can be removed without interfering with approximation of the edges of the wound. Chimney-sweeps and workers in paraffine should pay special attention to the condition of their skin by bathing frequently and treating any dermatitis with suitable ointments, powders, etc.

§ 232. **Injuries of the Tunica Vaginalis Propria and Communis.**—The testicle and epididymis are invested by the firm fibrous tunica albuginea. Outside of this is the visceral portion of the tunica vaginalis propria. The latter consists of a visceral portion which partially covers the testicle, and a parietal portion which lines the scrotal sac. This parietal portion is the pouch of peritonæum (processus vaginalis peritonei) that descends into the scrotum before the descent of the testicle itself. Under normal conditions the upper portion of this processus vaginalis peritonei becomes obliterated, and in this way the cavity formed by the parietal and visceral portions of the tunica vaginalis propria is shut off from the abdominal cavity. The visceral layer of the tunica vaginalis propria is the original peritoneal covering of the testicle during its location in the abdominal cavity. The posterior surface of the testicle, the globus minor and vas deferens, lie outside the tunica vaginalis propria. The vessels of the testicle enter the latter at this posterior portion. Next to the tunica vaginalis propria comes the tunica vaginalis communis of the testicle and cord, which is a continuation of the transversalis fascia of the abdominal wall, and was brought down into the scrotum at the time of the descent of the processus vaginalis peritonei. The tunica vaginalis communis is connected with the subjacent tunica vaginalis propria by loose cellular tissue, which is to be regarded as a continuation of the properitoneal cellular tissue. Wherever the tunica vaginalis propria is wanting on the posterior surface of the testicle we here find the tunica vaginalis communis attached to the testicle and epididymis; it surrounds, therefore, testicle, epididymis, and vas deferens completely.

The spermatic cord contains the vas deferens, which ascends from the globus minor of the epididymis through the inguinal canal, and the vessels (internal spermatic artery, artery of the vas deferens, pampiniform plexus) and nerves of the testicle and epididymis, all of which are joined together by loose connective tissue. The cord is covered by the tunica vaginalis communis and the cremaster, which arises from the internal oblique and transversalis muscles. Between the cremaster and tunica dartos lies Cooper's fascia, which is a continuation of the aponeurosis of the external oblique in the vicinity of the external inguinal ring. The external spermatic artery, vein, and nerve lie outside the tunica vaginalis communis. Beyond the internal ring the cord is composed only of the vas deferens and the internal spermatic vessels, the latter passing into the retroperitoneal space.

Injuries of the tunica vaginalis propria and communis, particularly subcutaneous contusions, have different clinical symptoms, depending upon the location of the effusion of blood, whether within the tunica vaginalis communis or propria or in the region of the testicle or spermatic cord.

An effusion of blood between the tunica vaginalis communis and propria is called a *hæmatoma extravaginale testis* (Kocher). These effusions, which are generally circumscribed, can usually not be distinguished from the subcutaneous hæmatomata beneath the dartos. A diffuse or more circumscribed effusion of blood is usually present in the cord at the same time (*hæmatoma funiculi spermatici*). Hæmatomata usually appear very promptly after injuries, especially contusions, and may reach an enormous size.

Extravaginal hæmatomata usually become completely absorbed and only rarely remain permanently, giving rise to thickening of the surrounding walls, just as in the case of hæmatoceles of the tunica vaginalis propria. Kocher saw an extravaginal hæmatoma as large as a child's head which had developed two years before, the patient having been run over.

The treatment of extravaginal hæmatomata resulting from a contusion consists in rest, elevation, and application of ice. If the hæmorrhage is not arrested by these means, and the hæmatoma enlarges, one may compress the venous plexus of the scrotum by means of the pad of a truss (Malgaigne, Kocher), or make a free incision, turn out the clots, and ligate the bleeding vessels. Old encapsulated extravaginal hæmatomata are treated in exactly the same way as hæmatoceles of the tunica vaginalis propria—i. e., by incision, evacuation, and drainage.

Intravaginal hæmatoma of the tunica vaginalis propria following injuries rarely occurs alone, but is usually combined with an extravaginal effusion. It not infrequently follows puncture of a hydrocele in consequence of wounding a vein or the testicle. A sudden increase in abdominal pressure, as in coughing, may give rise to hæmorrhage into the cavity of the tunica vaginalis, particularly when there is already a hydrocele present. An effusion of blood within the tunica vaginalis propria gives rise to the same form of swelling as the hydrocele, and here, too, the testicle lies below and behind. The size of the swelling is less than in an extravaginal hæmatoma. Spontaneous absorption takes place less frequently in the case of intravaginal effusions, and it is more common for a permanent hæmatocele to result, with hydrocele, chronic periorchitis, and thickening of the tunica vaginalis propria.

Treatment of Intravaginal Hæmatoma.—As spontaneous absorption of the effusion of blood is rare and the condition usually goes on to

the formation of a hæmatocele or hydrocele with periorchitis, it should be treated by a radical operation—i. e., incision and drainage, as in hydrocele.

§ 233. **Inflammations of the Tunica Vaginalis of the Testicle and Spermatic Cord.**—Acute inflammation of the tunica vaginalis propria (vaginitis or acute hydrocele) occurs in consequence of traumatism, extension of gonorrhœa to the epididymis and testicle, injection of tincture of iodine or carbolic acid after puncture of a chronic hydrocele, in the course of acute infectious diseases, such as scarlet fever, etc.

The symptoms of acute vaginitis or hydrocele consist in œdema and reddening of the scrotum, varying in amount and in the appearance of a painful elastic swelling, at the posterior part of which the tender testicle can be felt. If much fibrin is present, a distinct crepitus is felt. There is usually a slight amount of fever. Complete return to the normal takes place within two or three weeks, or the walls of the sac grow together and remain permanently thickened. Very frequently acute vaginitis passes into the chronic form, or hydrocele in the usual sense of the word.

The treatment of acute serous vaginitis or acute hydrocele consists of rest, elevation of the scrotum, and the application of an ice bag. As soon as the acute inflammatory symptoms have subsided the patient is allowed to wear a suspensory bandage. If the exudation is excessive in amount it should be evacuated by aseptic puncture, or one can perform a radical operation as in chronic hydrocele (see page 395).

Serous vaginitis sometimes passes into the purulent form (vaginitis purulenta), or the latter begins as such—for example, after injuries, non-aseptic puncture of a hydrocele, or in suppurative epididymitis and orchitis due to gonorrhœa or metastasis in acute infectious diseases. In such cases the inner wall of the sac is covered with a sero-fibrinous exudate and there is a larger or smaller collection of pus. In the most virulent infections sloughs are formed. Every case of suppurative vaginitis carries with it the danger of a progressive phlegmon with possible involvement of the peritonæum or of pyæmia and septicæmia if the pus is not promptly evacuated by incision and drainage. Spontaneous rupture frequently takes place in such cases, followed by the formation of fistulæ and healing with obliteration of the cavity of the tunica vaginalis.

The treatment of suppurative vaginitis demands prompt evacuation of the pus by free incisions, followed by disinfection with 1-to-1,000 bichloride and drainage.

Acute Inflammation of the Tunica Vaginalis of the Cord (*Hydrocele acuta funiculi spermatici, Perispermatitis serosa, seu serofibrinosa,*

Kocher) in an unobliterated portion of the processus vaginalis occurs either alone or in combination with acute vaginitis. As a rule there is a chronic serous inflammation or hydrocele of the cord, and this takes on an acute exacerbation. In such cases a circumscribed, tense, painful swelling appears more or less suddenly in the region of the inguinal canal, which may lead one to make the diagnosis of strangulated inguinal hernia. Several cases have been observed where, in consequence of irritation of the peritonæum, vomiting, distention of the abdomen, and collapse have made their appearance, which completed the similarity of the symptoms in the two conditions. The swelling is sometimes inside and sometimes outside the inguinal canal, or it may be both inside and outside. It sometimes extends well down into the scrotum and is either completely encapsulated or communicates with the abdominal cavity. All these possibilities will be taken up more in detail in treating of the usual or chronic form of hydrocele of the cord.

In rare cases the exudate may be purulent (perispermatis purulenta).

The treatment of acute serous perispermatis consists of rest, ice, or, if necessary, aseptic puncture, or, better, incision followed by irrigation with 1-to-1,000 bichloride and drainage, especially in case of suppurative inflammation.

Chronic Inflammations of the Tunica Vaginalis.—The most frequent inflammation of the tunica vaginalis is hydrocele (periorchitis serosa chronica), usually single, more rarely double. Hydrocele is sometimes congenital, and is very common in young children and in adults between twenty and forty years of age. It develops as a rule very gradually and is only rarely acute. Its usual causes are traumatisms, gonorrhœa, and disease of the testicle and epididymis.

Anatomical Changes in Hydrocele.—The effusion is usually clear, greenish, or blood-tinged, and varies very much in amount; it can reach one, two, or even three litres, thus giving rise to very large tumours. The testicle usually lies behind and above or below. The exudate is sometimes clouded by an abundance of desquamated endothelial cells and leucocytes or coloured red or brown by an admixture of blood (hæmatocele). The relative amount of fibrin in the exudate is also very variable. There is sometimes a large amount of cholesterin, and in rare cases the exudate changes into a thick mass containing a large percentage of cholesterin. Spermatozoa are found in the exudate in case a vas aberrans of the epididymis communicates by an abnormal congenital opening with the cavity of the tunica vaginalis propria, or a spermatocele has ruptured (hydrocele spermatica). According to Krause and König, most hydroceles contain spermatozoa which come from the hydatid of Morgagni.

If the effusion contains a large number of spermatozoa and leucocytes it may have a milky appearance (galactocèle). Hydrocele chylosa (chylocele)

is another form of galactocoele, and is caused by a flow of lymph (lymphorrhagia) into the cavity of the tunica vaginalis propria, resulting in the presence of a milky fluid. This latter form of galactocoele occurs particularly in genuine elephantiasis—i. e., among persons who have lived in the tropics. The dilated lymph spaces contain in some instances the *Filaria sanguinis*. In such cases ascites chylosus is present at the same time (Winckel).

The tunica vaginalis propria is usually thickened in hydrocele, and the testicle and epididymis are often hard and atrophic in case the hydrocele has lasted for a long time.

Symptoms of Hydrocele.—Subjective symptoms do not as a rule become marked until a large amount of fluid has collected, and consist then mainly in a feeling of weight and in interference with coitus and evacuation of urine in case the skin of the penis is pulled forward by the tumour. Erection of the penis is in such cases only imperfect, and the production of semen is interfered with by the pressure. Large hydroceles are often complicated by hernia. The growth of a hydrocele is in some cases rapid and in others much slower. It may rupture in consequence of a traumatism, and the effusion then distributes itself in the surrounding tissues; after absorption has taken place a relapse appears very quickly.

The diagnosis of hydrocele is usually easy. The soft elastic tumour of the scrotum, at the posterior part of which the testicle is situated, is completely shut off from the inguinal canal except in hydrocele bilocularis and hydrocele communicans (page 397). The tumour is usually translucent. This can be demonstrated in a dark room by holding a candle near the tumour and making the skin of the scrotum tense. Hydroceles that contain a bloody or cloudy fluid are not translucent.

Treatment of Hydrocele.—Spontaneous cure of a hydrocele is rare, and hence operative treatment is always to be recommended. The

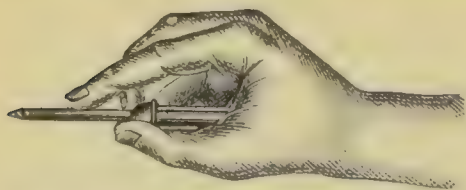


FIG. 576.—Method of holding the trocar in tapping a hydrocele.

simplest method is puncture of the hydrocele with or without injection of tincture of iodine, alcohol, carbolic acid, chloride of zinc, etc. In performing puncture the trocar should be held in the way shown in Fig. 576, and the scrotum is grasped from above with the left hand

in order to make the skin tense and compress the tumour. The trocar is then thrust in, possibly under local anæsthesia with cocaine or ether spray, from in front and below in an upward direction, in order that the testicle, which usually lies behind and below, may not be wounded. Before inserting the trocar, one should be sure of the position of the testicle. Puncture alone rarely brings about a cure, but usually one recurrence follows another. In order to secure adhesion of the parietal

portion of the tunica vaginalis propria with the visceral portion, puncture should be followed by the injection of irritating solutions, particularly tincture of iodine (5 to 15 grammes); absolute alcohol; Lugol's solution (1.5 iodine, 3.0 iodide of potassium, and 30 water); 10 to 15 grammes of a three- to five-per-cent solution of carbolic, or better, only 2 to 5 grammes of ten- to fifteen-per-cent carbolic acid and alcohol or carbolic acid and glycerin; chloride of zinc (1 to 10), etc. The injection of these solutions is usually followed by an acute, painful swelling, lasting for from eight to fourteen days. All statistics show that recurrences are more frequent than after the radical operation. Neumann recommends leaving in the canula for two days after puncture; he obtained in this way a permanent cure in seven days. A cure has also been obtained in from eight to ten days by drawing through a strip of iodoform gauze, a drainage-tube, or a piece of heavy silk (Buschke, Herbing).

A much better and surer method is to employ the radical operation by incision. The one most in use is Volkmann's, which is performed as follows: The cavity of the tunica vaginalis propria is laid open by a free longitudinal incision, emptied, and irrigated with 1-to-1,000 bichloride. The edges of the tunica are then sutured to the borders of the skin. A drainage-tube is usually unnecessary. The patient can get up at the end of eight or ten days, but the wound does not heal completely in some cases until the third week. The average duration of treatment by this method is, according to Hertzberg, sixteen and two thirds days.

The best radical operation consists in excision of as much as possible of the tunica vaginalis propria as practised by Bergmann, Brannan, and myself. After opening the cavity of the tunica vaginalis propria by a free incision, the latter is separated bluntly from the spermatic cord and tunica vaginalis communis with careful preservation of the spermatic vessels and vas deferens, and only a small portion is left in the vicinity of the testicle. The wound is drained and sutured, and an antiseptic compressive dressing applied which covers the lower abdomen and thighs like a pair of tights. The drainage-tube is removed at the end of the first twenty-four or forty-eight hours; the large

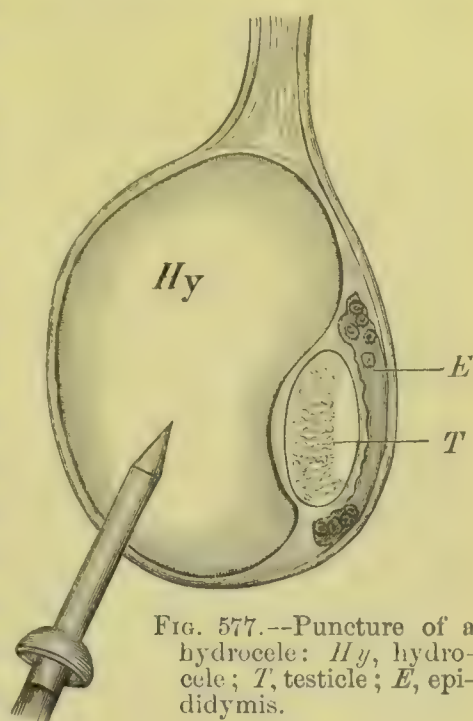


FIG. 577.—Puncture of a hydrocele: *Hy*, hydrocele; *T*, testicle; *E*, epididymis.

protective dressing can then be discontinued, and in its place I use a suspensory bandage and a piece of bichloride gauze. Of late I have been in the habit of packing the wound lightly and using a suspensory containing sterilized gauze and cotton. In children, also, I lay iodoform gauze into the wound, which rapidly dries and is removed in twenty-four hours. A protective dressing is not applied. I avoid antiseptics as far as possible in operations for hydrocele, and find that the wound has but very little reaction. Cicatrization takes place in from six to twelve days. Recurrences are surely avoided by this method of excision of the tunica vaginalis propria, and the duration of the treatment is very short.

Kocher and Juillard recommend preservation of enough of the tunica vaginalis propria to cover the testicle, so that there is no cavity. The tunica vaginalis propria is sutured with catgut, then the tunica vaginalis communis, and finally the skin. Kocher employs no drainage, while Juillard drains the outer wound.

Hæmatocele (Periorchitis Hæmorrhagica). — A hæmatocele may either arise from a hydrocele in consequence, for example, of injury of a vessel or the testicle from puncture, or a traumatism, or it may be due to a special form of inflammation called periorchitis hæmorrhagica. This hæmorrhagic periorchitis is characterized by an unusual vascularity of the inflamed tunic. Hæmatoceles which have lasted for some time usually form large tumours, and the walls of the sac are often thickened and contain plates of cartilage, lime, or bone. Hæmatoceles have a marked tendency to become acutely inflamed, and even to suppurate. The testicle and epididymis are often atrophied.

The best treatment of a hæmatocele consists in aseptic excision of the tunica vaginalis propria, especially as the latter is usually more or less thickened. In hæmatocele it is not rare for the testicle to lie in front and has been injured in making the incision. Kocher cut into it superficially, but inserted two sutures through the tunica albuginea and obtained healing without reaction.

Other Forms of Chronic Vaginitis or Periorchitis.—*Periorchitis seu vaginitis adhesiva* (Kocher) is characterized by membranous cordlike adhesions. If a serous exudation occurs in the spaces separated by the membranous adhesions a multilocular hydrocele may result (see page 398).

Periorchitis seu vaginitis prolifera (Kocher) results in new formation of tissue on the surface of the tunica vaginalis propria and in the interior of its cavity, and not infrequently in the deposit of lime and formation of bone. *Vaginitis seu periorchitis villosa* is a special form of vaginitis prolifera, and is characterized by the formation of sessile or pedunculated villous outgrowths, especially in the region of the epididymis, where normally small villous formations sometimes occur just as they do on the visceral layer of the

tunica vaginalis propria. In case the pedicle breaks off, these villous growths may become free bodies in the cavity of the tunica vaginalis. Proliferation of the endothelial cells of the tunica vaginalis and breaking off of a proliferated and pedunculated hydatid of Morgagni may likewise give rise to free bodies in the cavity of the tunica vaginalis, often in great numbers (Braun, Sultan).

Hydrocele of the Spermatic Cord (*Hydrocele funiculi spermatici cystica*, *Perispermatitis serosa*, Kocher).—Hydrocele of the cord arises from serous exudation in an unobliterated portion of the processus vaginalis and is in some cases circumscribed and situated outside or inside the inguinal canal, and in other cases involves the entire length of the spermatic cord or inguinal canal. An extrainguinal hydrocele of the cord may extend so far downward that it pushes the testicle to one side. Hydrocele of the cord is sometimes not closed on all sides, but may communicate either with the cavity of the tunica vaginalis propria or with the abdominal cavity. It is sometimes combined with a hydrocele of the tunica vaginalis. True hydroceles are to be distinguished genetically from cysts of the spermatic cord (see page 399).

Hydrocele of the cord is usually oval in shape and varies in size from a hazelnut or walnut to a pigeon's egg. Large hydroceles are sometimes shaped like an hour-glass in consequence of circular constriction. The largest hydroceles are those that lie outside the inguinal canal, and these may reach the circumference of a fist or child's head. In such cases of hydrocele of the cord alone the testicle can always be felt distinct from the tumour. The swelling is tense, elastic, and translucent, and can usually be distinguished without any trouble from a hernia or an undescended testicle (cryptorchismus).

There is also a hæmatocele of the cord which is due to the same causes as hæmatocele of the tunica vaginalis testis (see page 396).

The treatment of hydrocele of the cord consists in laying open the tunica vaginalis of the cord and excising as much of the sac as possible, which can usually be easily separated from the cord. In very large hæmatoceles of the cord it may be necessary to remove the testicle on that side in order to facilitate healing and be sure of arresting all hæmorrhage.

Other Forms of Hydrocele and Hæmatocele of the Tunica Vaginalis and the Cord.—1. *Hydrocele communicans*—i. e., a hydrocele of the cord or the tunica vaginalis propria which communicates usually by a small opening with the abdominal cavity in consequence of patency of the original processus vaginalis peritonei.

The treatment of hydroceles that communicate with the abdominal cavity consists in incising the sac, removing as much of it as possible, and then tying it off high up in the inguinal canal.

2. *Hydrocele seu hæmatocele bilocularis extra- and intra-abdominalis.* In this form of hydrocele there are two sacs which communicate by an opening which may be large or small. We distinguish with Kocher two varieties of bilocular hydrocele. In one variety both hydrocele sacs lie outside the abdominal cavity (hydrocele *seu* hæmatocele bilocularis extra-abdominalis). They may both lie in the scrotum, for example, or one in the scrotum and the other in the inguinal canal (hydrocele bilocularis scrotalis and inguinalis), or in the region of the perinæum (hydrocele bilocularis perinealis). In the second variety one sac lies inside the abdomen (hydrocele bilocularis intra-abdominalis) and the other outside. Intra-abdominal hydrocele may also occur by itself without the presence of an extra-abdominal sac. In case there is both an extra-abdominal and intra-abdominal sac, the two may be entirely separate, but more frequently they communicate with one another by an opening which is usually inside the inguinal canal. In the latter case the contents of the scrotal hydrocele can be pressed more or less completely into the intra-abdominal hydrocele and the connection of both tumours demonstrated in this way. This is often not possible in the case of hæmatoceles with rigid walls. I saw a case of intra-abdominal hydrocele as large as a man's head. Sacs that lie inside the abdomen are covered by peritonæum and lie usually between the latter and the abdominal wall in the inguinal region. The abdominal sac is formed either by the growth of a hydrocele or hæmatocele of the cord in the direction of the abdominal cavity, the peritonæum being lifted up more and more from the abdominal wall, or the intra-abdominal sac has arisen at the outset inside the abdominal cavity in consequence of congenital anomalies of development, such as a diverticulum of the processus vaginalis, as in a properitoneal hernia.

The best treatment of bilocular hydrocele or hæmatocele, as far as the extra-abdominal sacs are concerned, is by free incision and as complete as possible extirpation of the same, followed by drainage. Excision in the case of intra-abdominal sacs, especially when they are large, may be very difficult on account of the extensive adhesions, and particularly in hæmatoceles with rigid walls. Generally speaking, one will have to content himself in the case of intra-abdominal hydroceles and hæmatoceles with extraperitoneal incision and drainage and removal of only a portion of the sac.

3. *Hydrocele seu hæmatocele multilocularis.* There are sometimes several sacs present both in a hydrocele of the cord and of the tunica vaginalis. Multilocular hydrocele of the tunica vaginalis is the rarer. Several other conditions have been erroneously described as multilocular hydrocele, such as cystic tumours, lymphangeiomata, congenital cysts of the epididymis and spermatic cord, spermatoceles, echinococcus cysts, etc. Genuine multilocular hydroceles are rare, and are to be ascribed, in the main, to disturbances in development—for example, of the gubernaculum testis Müller's duct, or the Wolffian body.

4. Various combinations of the several varieties of hydrocele are not uncommon.

5. Hernia may be present in conjunction with the various forms of hydrocele. An inguinal hernia may extend down to the sac of a hydrocele of the tunica vaginalis or the cord, or even farther, so that the hernial sac comes to lie behind the hydrocele.

In still other cases the sac of the hydrocele is invaginated by the hernia, so that the latter is more or less surrounded by the hydrocele (hernia encystica, see page 214, Fig. 498). There is sometimes a serous or hæmorrhagic effusion within an empty hernial sac (hydrocele *seu* hæmatocele hernialis). The hernial sac is either open, so that the entire serous or hæmorrhagic contents can be forced back into the abdominal cavity, or it is closed.

6. Diffuse hydrocele. As contrasted with the typical circumscribed hydrocele, a diffuse form has been described which is in the main a chronic œdema of the cellular tissue of the spermatic cord and tunica vaginalis, due, for example, to rupture of a spermatocele or a hydrocele of the cord or tunica vaginalis from traumatism, etc. Although this explanation is probably the right one, it still remains in doubt why in such cases the exudate is not promptly absorbed.

7. Hydrocele is sometimes complicated by tubercular or syphilitic inflammation, particularly in case of like disease of the testicle and epididymis.

8. Hydrocele in the female. Cystic tumours sometimes develop in the canal of Nuck, which is analogous to the processus vaginalis in the male. Changes in the round ligament during pregnancy, labour, and the puerperium predispose to the development of this form of hydrocele. Here also we find varieties that communicate with the abdominal cavity. These cysts can be easily distinguished from other cysts in this region, such as those of Bartholin's glands, or closed and empty hernial sacs. A suppurating hydrocele may, however, be mistaken for a strangulated hernia. The treatment of hydrocele in the female consists in extirpation of the same, followed, if necessary, by suture of the inguinal canal, which is usually dilated, in order to prevent a future hernia.

§ 234. Tumours of the Tunica Vaginalis and the Spermatic Cord.—

Primary tumours of the tunica vaginalis and cord are rare, the most frequent being lipomata, fibromata, myxomata, enchondromata, myomata, dermoid cysts, other cysts, and sarcomata. Cysts of the cord are either serous or contain spermatozoa. The first variety have developed either from an empty hernial sac, or remains of the canal of Nuck, and the second class from the vas deferens, vas aberrans, and the paradidymis. Among animal parasites, echinococcus cysts have been described. The most frequent tumours are the lipomata of the spermatic cord, which form circumscribed tumours sometimes of an enormous size, and sometimes more diffuse fatty growths (diffuse lipoma). Sarcomata of the cord and tunica vaginalis are likewise circumscribed, or more diffuse growths which may reach a very large size. A differential diagnosis from malignant tumours of the testicle and epididymis may be difficult or impossible.

The treatment of tumours of the tunica vaginalis and spermatic cord consists in extirpation of the same, according to general rules. In the case of malignant tumours, especially, it will be necessary to remove the testicle as well.

§ 235. **Varicocele.**—By varicocele is meant an abnormal dilatation of the veins of the spermatic cord, and is analogous to varicose veins of the lower extremities. Varicocele is very common in young individuals and at the period of greatest sexual activity. It seems to be particularly common in England. Curling states that out of the recruits examined during ten years 23·5 per thousand were rejected on account of varicocele. The causes of varicocele are in general the same as those of other varicose conditions, and consist mainly of obstruction to the venous circulation with increase in the hydrostatic pressure in the veins of the cord from different causes, such as standing for long periods, constipation, etc. It sometimes develops in an acute way after a traumatism. Another important etiological factor is a congenital predisposition—i. e., a congenitally weak resistance of the walls of the veins to the intravascular pressure which is increased from some cause. A new formation of veins also takes place. Varicocele is more common on the left side, because the left spermatic vein empties into the renal vein almost at right angles, and venous stasis can thus easily arise. The left testicle also hangs lower than the right one as a rule, so that the hydrostatic pressure is for this reason greater on the left side. The right spermatic vein, on the other hand, empties into the vena cava at an acute angle.

The anatomical changes in varicocele are more or less marked, depending on its degree. The dilated veins can be felt extending from the testicle to the external inguinal ring. The veins just above the testicle are the ones most enlarged. After a varicocele has lasted for some time the veins of the parenchyma of the testicle also become dilated. The circulation may become completely arrested in the veins of the cord, so that thrombi are formed, and, in consequence of calcification of the latter, phleboliths.

The symptoms of varicocele are very variable. It may give the patient so little trouble that he is ignorant of its existence. In other cases, however, patients complain of an unpleasant sensation of weight and burning in the testicle and along the cord, or of real pain in the scrotum which radiates toward the loin and up into the abdomen, particularly after standing for a long time or exercising violently. There is sometimes marked neuralgia of the scrotum and testicles, disturbances of the sexual function, diminution of sexual appetite from atrophy of the testicle, etc. Pollutions are sometimes caused by varicocele. In rare cases thrombosis and phlebitis take place, and even death has been known to occur from suppurative phlebitis. Volkmann saw gangrene of the testicle result from venous thrombosis in a varicocele.

The diagnosis of varicocele is easy, as one can feel the dilated veins, which give the sensation of a bag of worms, and in marked cases the bluish veins can be seen through the skin. The swelling at the lower part of the cord just above the testicle may reach the size of a pigeon's or hen's egg. When the patient lies down the swellings caused by the varicocele disappear.

As regards the prognosis of varicocele, it should be stated that the latter often disappears spontaneously, particularly after marriage, with regulation of the sexual function and with increasing years (Socin, Kocher).

Treatment of Varicocele.—In mild cases the patient should wear a suspensory, employ cold baths locally, and remedy any predisposing causes, such as constipation. Sexual excitement and too frequent coitus are to be avoided. Curling recommends elastic compression of the varicocele by means of a truss.

Operative treatment is indicated only in case it causes much trouble. I have repeatedly had good results by removing a portion of the scrotum, but recurrence is very likely to take place. Ricord recommended subcutaneous ligation of the veins of the cord. After isolation of the vas deferens an aseptic loop of catgut, silk, or silver wire is carried through from each side, one in front of and the other behind the veins that are to be tied off, and both ends of each ligature are passed through the loop on the same side (Fig. 578) and tied together over a roll of adhesive plaster or a piece of wood or pasteboard. The application of a single ligature is sufficient. The ligature is removed at the end of from eighteen to twenty hours. Subcutaneous ligation is painful, and there is always danger of suppuration. The best operation consists in excision of some of the dilated veins. The operation is to be performed cautiously; a sufficient number of veins are to be left and the arteries should not be cut, as gangrene of the testicle may occur. Kocher performs the operation under cocaine with the patient in a half-sitting posture, as the veins are then better filled. The skin of the scrotum and the investments of the cord are divided at one or more places, the dilated veins which appear are isolated, each bunch is doubly ligated, and the intervening portion excised. The wound is closed without drainage by means of deep skin sutures, covered with sterile gauze, and a suspensory applied. The patient should stay in bed until the wound has healed.



FIG. 578.—Ricord's subcutaneous ligation of a varicocele.

Torsion of the Cord and Testicle.—This condition, which was first described by Nicoladoni, has only been accurately observed in a few isolated cases. Nash has collected twenty cases from medical literature. In order to allow of torsion, the testicle must lack its normal fixation and be more or

less freely suspended. The cord or mesorchium is usually abnormally formed; the latter may be, for example, too long. Traumatism also plays an important part. In the differential diagnosis of torsion of the testicle the suddenness of the onset and the possibility of a coexisting hernia, such as a properitoneal hernia, may lead one to think of strangulation of intestine or omentum, appendicitis, etc. In consequence of twisting of the cord, circulatory disturbances follow, and finally gangrene of the testicle if the strangulation is not relieved by cutting down on the cord and testicle. The operation should not be delayed too long. It is more necessary to preserve a testicle that is in the scrotum than one that is undescended.

§ 236. **Deformities of the Testicle.**—Among deformities of the testicle, anomalies in its location will first be taken up, and of these, retained or undescended testicle is the most important. In retained testicle the organ is arrested at some point during its descent from the abdominal cavity into the scrotum, usually in the vicinity of the internal inguinal ring, in the inguinal canal, or at the external ring, and more rarely within the abdominal cavity. There are two main varieties—the abdominal testicle and the inguinal testicle. If both testicles are retained the condition is known as cryptorchismus or cryptorchidism; and if but one, monorchismus or monorchidism. Undescended testicle is a fairly common anomaly. Retention of the testicle is to be distinguished from so-called ectopy of the testicle; in the former the testicle is always found at some place in its normal descent, while in ectopy the testicle is at some point which is not traversed during its normal descent from the abdomen. Ectopy (page 404) is always the result of a previous retention of the testicle, but the former is much rarer than the latter. In case both testicles remain within the abdominal cavity, they may be fused together, a condition which is known as synorchism. Saint-Hilaire saw fusion of both testicles, both kidneys, and both suprarenal capsules, a condition which has never been reported before or since in medical literature. The causes of undescended testicle are usually arrested development, obstacles to the normal descent of the testicle—for example, malformation of the sexual organs, intra-abdominal and extra-abdominal adhesions of the testicle, etc. The anomaly of location sometimes seems to be hereditary. A testicle that has already descended into the scrotum may also be forced back into the inguinal canal or the abdominal cavity as the result of an injury, for example (dislocation of the testicle, see page 405).

The symptoms of undescended testicle consist in emptiness of one or both halves of the scrotum, in spite of which the vas deferens and cord may extend down into the scrotum. If the testicle is situated at the internal or external inguinal ring or in the inguinal canal, it can then be felt through the skin and the abdominal wall. A testicle in

the inguinal canal may be mistaken for a hydrocele of the cord, but hardly for an inguinal hernia, although the former is not infrequently associated with the latter. The sequelæ of retention of the testicle consist mainly in atrophy of the testicle, particularly when in the inguinal canal, in consequence of fatty degeneration and fibrous contraction of the same. Inflammatory swelling and, as a result of this, strangulation of the testicle, sometimes occur from traumatisms, gonorrhœa, and torsion of the cord. In consequence of torsion of an undescended testicle, circulatory disturbances going on to partial or complete gangrene may take place. An undescended testicle is frequently the seat of a tumour, particularly carcinoma. Fischer collected forty and Kocher fifty-six cases of tumours of an undescended testicle. A retained testicle may descend into the scrotum at any time after birth up to the time of puberty. After puberty, however, an undescended testicle remains permanently in its abnormal location, causes the patient a certain amount of pain, brings with it the danger of inflammation and malignant change, and becomes useless in consequence of gradual atrophy.

Treatment of Undescended Testicle.—Treatment is necessary only in case the testicle is situated in the inguinal region and not when it lies inside the abdomen. Reduction may be accomplished either with or without operation. Treatment without operation is indicated mainly when the testicle lies just outside the external inguinal opening. In such cases it is sometimes a good plan to apply a truss with a fork-shaped or ordinary pad to press the testicle downward. It is also advisable to push down or draw down the testicle into the scrotum by repeated manipulations at regular intervals. If these procedures are not successful one may employ the operation that has been successfully used by Schüller, Nicoladoni, Kocher, the author, and others. The subjective annoyances were overcome by the operation, but not the already existing atrophy of the testicle. Replacement by operation is, in my opinion, suited mainly to those cases where in young individuals the testicle can be felt to be movable and is not atrophied, and the subjective annoyances have lasted only for a short time. I agree with Bésançon that the best time for operating is between the tenth and thirteenth year.

The technique of operative replacement is briefly as follows: The testicle is cut down upon by dividing the skin, subcutaneous cellular tissue, and fascia. The tunica vaginalis communis is then divided transversely, in order that the testicle may be drawn downward. It is important also to free the spermatic cord completely. After having been brought down into the scrotum, the testicle is secured with sutures

of catgut. The open processus vaginalis is then excised and the external inguinal ring closed by suture. In order to make it impossible for the testicle to slip back, Kocher recommends fastening the spermatic cord as its entrance into the scrotum by a circular suture, which does not, however, constrict it.

In case there is a hernia present at the same time, this should be treated by a radical operation.

If an undescended testicle is diseased or causes much trouble, it should be extirpated. Kocher rightly states that an undescended testicle requires removal much more frequently than one normally situated. It should always be borne in mind that an undescended testicle in an individual beyond the age of puberty atrophies more and more, causes him pain, and carries with it the possibility that it may become the seat of a malignant tumour. For these reasons its extirpation is a thoroughly justifiable operation.

Ectopy of the Testicle.—As already mentioned above, ectopy means the abnormal location of the testicle at a point not traversed during its normal descent. The testicle may, for example, be situated in the anterior abdominal wall between the peritonæum and the other layers of the abdominal parietes, in the perinæum, in the thigh at the region occupied by femoral hernia, or between the scrotum and thigh, in the pelvis, etc. Like retained testicle, ectopy of the testicle is sometimes associated with hernia. We are at present entirely without an exact knowledge of the etiology of the different varieties of ectopy of the testicle, but an abnormal attachment of the gubernaculum is probably the chief factor. In some animals, such as pigs, the testicles are normally situated in the perinæum. The treatment of ectopy of the testicle is, generally speaking, the same as that of retained testicle (see page 403).

Inversion of the Testicle.—By inversion of the testicle is meant an abnormal position of the same, owing to its being turned on its vertical or horizontal axis. It is most common to find the testicle turned on its vertical axis, so that the epididymis lies in front. The etiology of this condition is unknown. Inversion of the testicle is especially important with reference to operations for hydrocele by puncture, and particularly by incision. In the latter case the knife may wound the cord, epididymis, and testicle before the tunica vaginalis is opened. Curling did this in a case of this sort, and he was obliged to remove the wounded testicle.

Absence of the Testicle (Aplasia Testis) is very rare. Gruber has, however, collected twenty-three cases of unilateral and eight cases of bilateral absence of the testicle. The absence or partial defect of the epididymis with normal testicle is also rare.

Congenital imperfect development or atrophy of the testicle is fairly common. Acquired atrophy results usually from injuries of the cord, testicle, spinal cord, and brain, or from syphilis, tuberculosis, etc.

Hypertrophy of a testicle occurs usually in case of atrophy of the other. The weight of the normal testicle in the adult is from sixteen to twenty-six

grammes. Page observed in one case of monorchidia a testicle weighing seventy-one grammes.

Brown-Séquard has experimented with the secretion from the testicles of the ape and guinea-pig in order to determine its physiological effect upon man. He claims to have seen marked general and local improvement in old men with insufficiency of the bladder, hypertrophy of the prostate, nervous diseases, etc. Others have had negative results.

§ 237. **Injuries of the Testicle and Epididymis.**—Contusions of the testicle are generally caused by a kick, blow, fall, in horseback riders by striking against the pommel of the saddle, or by a spent bullet. They usually cause intense pain. Serious reflex manifestations sometimes make their appearance, such as vomiting and syncope, and the latter has been known to end fatally from paralysis of the heart (H. Fischer, Schlesier). Contusions give rise to a variable amount of effusion of blood into the substance of the testicle and into the subcutaneous cellular tissue, and sometimes a hæmatocele of the tunica vaginalis propria results from rupture of the albuginea and the visceral layer of the tunica vaginalis propria. Similar effusions or a traumatic inflammation of the testicle may also arise from straining the abdominal muscles, as in heavy lifting, which causes a forcible contraction of the cremaster and presses the testicle up against the inguinal ring. The course of contusions of the testicle is favourable, and in mild cases complete absorption of the effusion takes place. Severe contusions frequently result in atrophy of the testicle and epididymis. Suppuration occurs only when microbic infection has taken place from without or by way of the blood-vessels and lymphatics, and particularly in case of coexisting gonorrhœa. Tuberculosis of the testicle has frequently been known to follow contusion of the same in phthisical subjects.

The treatment of contusions of the testicle consists in elevation of the scrotum and in the application of ice, and subsequently in the use of a suspensory bandage for a considerable time. In case suppuration takes place, a prompt incision is indicated.

Dislocation of the Testicle.—In very rare cases the testicle is displaced by blunt violence, from its normal location in the scrotum. Bruns distinguishes the following varieties of dislocation :

1. *Luxatio testis abdominalis*—i. e., dislocation of the testicle beneath the skin of the mons veneris, over the root of the penis, etc.
2. *Luxatio testis cruralis*, in which the testicle is found on the inner side of the thigh.
3. *Luxatio testis perinealis*, or displacement toward the perinæum.
4. *Luxatio testis inguinalis*, in which the testicle is pushed upward into the inguinal canal.

In treating dislocation of the testicle one should first attempt to replace it by manipulation, and if this does not succeed, employ operative measures

similar to those described for congenital misplacements of the testicle (see page 403).

Wounds of the Testicle.—Puncture wounds of the testicle are, generally speaking, not dangerous, and are caused usually by the point of a trocar in tapping a hydrocele. This usually results in a hæmatocele of the tunica vaginalis propria. All puncture wounds made by an aseptic instrument generally heal quickly if the patient is kept quiet. For the course of a subsequent orchitis or epididymitis see § 238.

Incised wounds of the testicle which may in the same way result from incision of a hydrocele usually give rise to prolapse of the substance of the testicle in consequence of retraction of the albuginea that has been divided. By suturing the albuginea aseptically one may obtain healing without reaction. In case it is seriously wounded or there is danger of gangrene, the testicle should be removed in order to prevent secondary phlegmon and sepsis. For a description of injuries of the scrotum with prolapse of the testicle see page 387.

Injuries of the spermatic cord have already been referred to in § 232, page 391. Subcutaneous rupture of the vessels of the cord and the vas deferens may give rise to gangrene of the testicle. Special treatment is in some cases unnecessary. In open ruptures of the vessels of the cord, on the contrary, immediate removal of the testicle is indicated as soon as the latter shows signs of suppuration followed by gangrene.

The so-called "idiopathic gangrene" of the testicle results usually from torsion of the cord (see page 401) and from embolism and thrombosis of the internal spermatic artery, as the latter is a terminal artery. Idiopathic gangrene usually begins by the sudden appearance of a swelling of the testicle with the formation of a hæmorrhagic infarct and general febrile disturbances in case, for example, the thrombosis is of an infectious nature. It results either in shrivelling of the testicle without suppuration, or, in case of an infectious process, with suppuration. Volkmann, Maas, Nicoladoni, and others have reported cases of this idiopathic gangrene of the testicle in consequence of torsion of the cord and thrombosis and embolism of the internal spermatic artery. The best treatment consists in the removal of the gangrenous testicle.

§ 238. **Acute Inflammation of the Testicle and Epididymis (Orchitis and Epididymitis).**—Acute orchitis and epididymitis result most commonly from the extension of acute inflammations of the urethra, prostate, and bladder to the vas deferens, or from injuries, or secondary infection through the blood in the course of acute infectious diseases (variola, typhoid, scarlet fever, malaria, pyæmia, mumps, etc.). Acute epididymitis is the most common; acute orchitis usually develops after an epididymitis.

The symptoms of acute inflammation of the testicle and epididymis consist mainly in a rapidly increasing swelling and in severe pain. The shape of the swelling varies, depending upon whether the epididymis or the testicle is chiefly involved. Fig. 579 represents the difference in the shape of the swelling in orchitis, epididymitis, and hydrocele. The swollen testicle or epididymis is very tender on pressure. The temperature rises not infrequently to 40° C. (104° F.) during the first few days. In most cases complete return to the normal takes place in from two to four weeks if we leave out of consideration

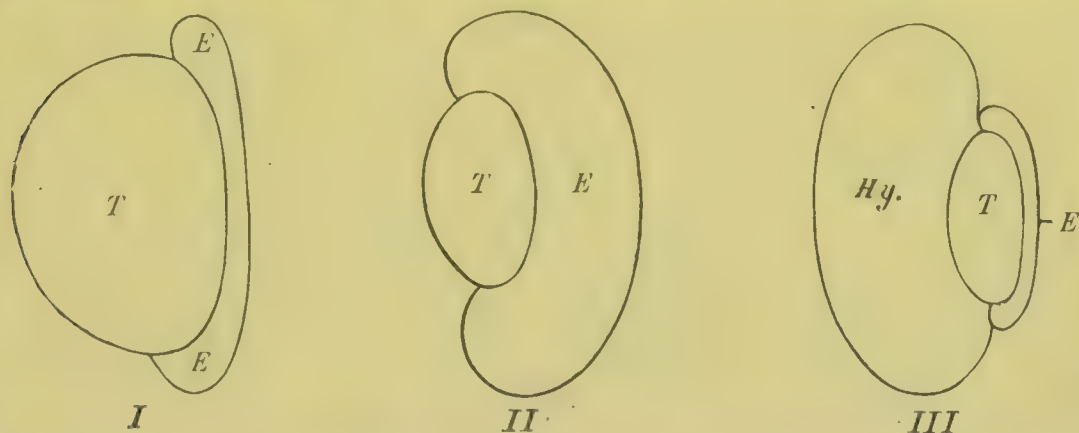


FIG. 579.—*I*, shape of the swelling in orchitis (*T*, testicle; *E*, epididymis). *II*, shape of the swelling in epididymitis (*T*, testicle; *E*, epididymitis). *III*, shape of the swelling in hydrocele (*Hy.*, hydrocele; *T*, testicle; *E*, epididymitis). Diagrammatic.

the abortive cases, which last only a few days. The inflammation sometimes goes on to the formation of pus, which either breaks through externally or is evacuated by an incision. One sometimes observes fistulæ of the testicle with fungous granulations (*fungus benignus testis*). In rare cases the pus focus may become encapsulated. Foci are sometimes found which have a very thick capsule and contain cholesterolin, or there may be a cyst, etc. Other complications that may be mentioned are extension of the inflammation to the neighbouring organs, obliteration of the vas deferens, followed in case of obliteration of both vasa deferentia by sterility, thrombosis and embolism of the vessels of the cord, atrophy or gangrene of the testicle, etc. The orchitis occurring in malaria is often followed by atrophy of the organ. In the most severe cases which do not receive proper treatment death may be caused by sepsis or extension of the inflammation and suppuration to the peritonæum and pelvic cellular tissue.

The treatment of acute epididymitis and orchitis consists in elevation of the scrotum, absolute quiet, and the application of ice. Energetic catharsis is very useful, especially at the outset. Repeated warm baths diminish the pain. For the latter one may also give hypodermic injections of morphine and narcotic rectal suppositories.

The galvanic current also gives relief, the positive pole being placed on the testicle and the negative pole on the cord. I also like careful inunctions of blue ointment. As soon as the acute inflammatory manifestations are over and the pain has subsided, one should employ moderate compression of the testicle and epididymis, preferably by means of an elastic suspensory made of India rubber. The suspensories devised by Langlebert, Neisser, and Falkson are also to be recommended. Rest in bed and ice should not be kept up for too long a time. In case the patient can walk about, the following method of dressing is serviceable: The scrotum is well besmeared with vaseline and covered with rubber tissue with a hole for the penis, then cotton and a suspensory, so that by evaporation of the perspiration that forms on the scrotum, the whole dressing makes an efficient means of applying moist heat. I no longer strap the testicle with strips of adhesive plaster, as was so commonly done at one time; I consider this procedure not only unpleasant for the patient, but also somewhat dangerous. If one suspects pus, it is a good plan to insert a needle; and if pus is present a free incision is made. In orchitis due to malaria quinine acts very well, while every form of local treatment is unsuccessful.

Acute inflammation of the spermatic cord (*funiculitis acuta*) and of the vas deferens (*spermatitis seu deferenitis acuta*) are usually found in conjunction with acute orchitis and epididymitis, and they precede the latter in all those inflammations which spread along the cord from the urethra, bladder, and prostate to the testicle and epididymis. In case, however, of primary disease of the testicle and epididymis, the inflammations of the cord and vas deferens are secondary. Inflammation of the vas deferens may give rise to obliteration of the same, followed by sterility in case both are closed. In case of inflammation of the vas deferens alone, the same can be felt as a cylindrical thickened cord about the size, for example, of a lead-pencil, particularly in the case of tuberculous processes. In case the inflammation involves mainly the interstitial tissue of the cord, one usually finds a more diffuse swelling. Inflammation and thrombosis of the vessels of the cord may, as mentioned on page 406, lead to gangrene of the testicle.

The treatment of acute funiculitis and spermatitis is practically the same as that of acute epididymitis and orchitis, which are usually present at the same time (see page 407).

§ 239. **Chronic Inflammations of the Epididymis and Testicle.**—Chronic inflammations of the epididymis and testicle either result from acute processes or begin as such. There are two forms of chronic epididymitis and orchitis, one of which gives rise to growth of fibrous tissue and induration, with corresponding contraction of the glandular tissue, while the other is a chronic suppurative process with the formation of abscesses which may be encapsulated or have fistulous tracts leading into them. Granulation tissue usually grows out in abun-

dance from the fistulæ (*fungus benignus testis*). Both processes may gradually lead to destruction of the parenchyma of the testicle and epididymis, so that its place is finally taken by hard, fibrous, or broken-down nodules.

The treatment of chronic orchitis and epididymitis is symptomatic in character. Fistulæ should be slit open and scraped out, and in case the symptoms are sufficiently severe or there is profuse suppuration, removal of the testicle may be indicated. Circumscribed fibrous nodules can sometimes be made to disappear by inunctions of *unguentum hydrargyri*, warm baths, especially mud baths, etc.

The most important chronic inflammations of the epididymis and testicle are the tubercular and syphilitic.

Tubercular Epididymitis and Orchitis.—Tuberculosis of the epididymis and testicle is probably the most frequent disease of these organs, and begins usually in the epididymis, seldom in the testicle. In the majority of cases there is coexisting tubercular disease of other organs, particularly of the genito-urinary tract (bladder, kidney, prostate, seminal vesicles) and the lungs, or general miliary tuberculosis, but tuberculosis of the testicle and epididymis may occur alone. Tuberculosis of the epididymis, which usually appears first, begins, like all tubercular inflammation, with the formation of miliary tubercles, which coalesce to form larger nodules, and with sero-purulent inflammation of the seminal tubules. In case tuberculosis of the epididymis and testicle develops from tuberculosis of the genito-urinary tract by way of the vas deferens, the latter can be felt as a hard cord the thickness of a pencil or even a finger. The testicle is usually involved secondarily from the epididymis, and the tubercular process is here also characterized by diffuse caseation, with catarrhal inflammation of the seminal tubules. In primary tuberculosis of the testicle the nodules that are formed are usually of a larger size. The enlargement of the epididymis and testicle caused by tuberculosis is very variable, being sometimes slight and in other cases very marked.

The cause of tubercular orchitis and epididymitis is the tubercle bacillus, which invades by preference the testicle and epididymis of persons already tubercular. Traumatisms and inflammatory processes are also predisposing factors. According to Baumgarten, the first pathological change produced by the bacillus consists in a proliferation of the fixed tissue cells, particularly the endothelia of the capillaries, while a profuse emigration of leucocytes does not take place until later. For a more detailed description of tuberculosis in general the reader is referred to § 83 of *Principles of Surgery*.

The further clinical course of tubercular epididymitis and orchitis

is variable. It may become very chronic, lasting for years, or have a subacute or acute course, giving rise in a few months or even weeks to fistulae, fungous granulations, and rapid destruction of the testicle. In these acute cases the other testicle is soon infected. The acute cases are in my experience the more common, so that I regard the prognosis as very grave and consider it as in the same category with carcinoma. The patients usually die very soon of coexisting tuberculosis of the lungs or genito-urinary tract or of general miliary tuberculosis. Primary tuberculosis of the testicle alone offers the best prognosis, as it usually runs a very chronic course and can be permanently cured by removal of one or both testicles. It is a remarkable fact that tuberculosis of the testicle is frequently combined with tuberculosis of the spine (W. H. Bennett, Reclus).

The diagnosis of tubercular orchitis and epididymitis is made from the presence of the tubercle bacillus and the coexistence of other tubercular disease, particularly of the genito-urinary tract and the lungs. The swelling of the epididymis and testicle takes place gradually, and the subjective disturbances at the outset are not nearly so marked as in ordinary epididymitis and orchitis. When the swelling develops very slowly it may be mistaken for syphilis.

Treatment of Tubercular Orchitis and Epididymitis.—Removal of the testicle and epididymis is indicated in case the tubercular focus has broken down and can be thoroughly removed by the operation, and hence in primary tuberculosis of the testicle and epididymis, in which the disease affects only that portion of the vas deferens that can be reached, while the abdominal portion of the same is still intact. In such cases, when both testicles are diseased, double castration may be necessary in order to protect the organism from secondary tubercular infection. I have also had good results in tuberculosis of both testicles from the injection of sterilized ten-per-cent iodoform-glycerin emulsion. I can recommend these iodoform injections very highly, and think that they should take the place of operative procedures, particularly in case of tuberculosis of both testicles, and especially in young individuals who can scarcely make up their minds to a double castration. If the tubercular deposit is confined to the epididymis, Bardenheuer recommends resection of the latter, with preservation of the testicle and the power of coition. I am in general of the same view as Kocher, Dürr, and others, that every partial operation for tuberculosis of the epididymis is inadvisable, as the testicle itself is involved in the great majority of cases. In case the vas deferens is tubercular, Büngner recommends castration as high up as possible, with avulsion of the vas deferens. One can in this way remove about

four fifths of the vas. Schede is right in giving a warning against this avulsion of the tubercular vas deferens, because in case the peritonæum is torn at the same time a tubercular peritonitis may easily ensue. Tubercular seminal vesicles may be removed through the perinæum by the method of Dittel and Zuckerkandl (see page 433) or by the sacral route recommended by Rydygier (see page 432). All those operated upon for tuberculosis of the testicle and epididymis should be kept under observation, on account of the possibility of a recurrence.

Syphilitic Orchitis and Epididymitis.—As distinguished from tuberculosis, syphilis usually attacks the testicle first, and it is only rarely that the epididymis is primarily affected. Syphilitic orchitis and epididymitis is not at all rare in the later stages of syphilis, and occurs mainly in two forms—viz., as a fibrous induration of the interstitial tissue, with gradual atrophy of the glandular substance, and as circumscribed gummata which usually lie within dense connective tissue. Both forms of syphilitic inflammation, which are usually combined, cause more and more destruction of the tissue of the testicle. Softened gummata not infrequently break through externally. The swelling in a syphilitic testicle is usually firm, painless, and either uniformly smooth or nodular, uneven, and confined to certain portions of the organ. The course of syphilitic orchitis is very chronic, and in the majority of cases both testicles are diseased, because one testicle is infected more or less quickly by the other.

The treatment of syphilitic orchitis is the same as for syphilis in general—inunctions, iodide of potassium, etc. By these means the tumour usually becomes smaller and the pain disappears. This improvement in the symptoms is, of course, of great value as regards the differential diagnosis from tuberculosis or a malignant tumour; otherwise the treatment of the local process is symptomatic.

Leprosy of the Testicle and Epididymis.—Leprosy may also give rise to inflammatory nodules in the testicle and epididymis, with corresponding atrophy of the same after the nodules have broken down.

Neuralgia of the Testicle.—Patients sometimes complain of continuous or periodic pain in the testicle. The causes of this neuralgia are very variable, and include excesses in venery (irritable testis of Cooper), narrowing and obliteration of the vas deferens, previous orchitis and epididymitis, adhesion of the testicle, hydrocele operations, varicocele, etc. In another category of cases neuralgia of the testicle is more sympathetic or reflex in nature—for example, in diseases of the bladder, kidneys, spine, and spinal cord, particularly in stone, diseases of the urethra, the prostate, and the seminal vesicles, with hyperæsthesia of the prostatic portion and the caput gallinaginis (Ultzmann), etc. The treatment of neuralgia of the testicle depends upon its cause. In suitable cases neurectomy of the external spermatic nerve is advisable. Heinlein resected with success the genito-crural nerve, or rather its two branches, the lumbo-inguinal and external spermatic in the region of the iliac fossa, in a case of neuralgia of the testicle with pain radiating toward the thigh and the hypogastrium. Exposure of these nerves which

are given off by the crural plexus is like that of the external iliac artery. Castration has been performed in severer cases and with good results.

§ 240. **Tumours of the Testicle, Epididymis, and Vas Deferens.**—Fibromata are found in very rare cases in the rete testis and the albuginea. Curling and Kocher each mention two cases. Kocher also mentions a fibroma of the vas deferens. Fibromata of the testicle are characterized by a very slow growth, extending over many years, and an extremely hard consistence.

Pure enchondromata of the testicle are rare. Dauvé mentions five cases and Kocher three. The cartilaginous mixed tumours are more common, which develop mainly in the centre of the testicle. They consist of one or several small and very hard nodules which usually contain hyaline and less often fibrous cartilage. The epididymis is generally intact. The prognosis seems to be grave, particularly in the mixed forms of chondroma, as metastases have been very frequently observed from growth of the tumour into the lymphatics. This has also been known to occur in pure chondromata.

Osteomata are formed in rare cases from ossification of a chondroma. Kocher mentions a case reported by Neumann. The production of cartilage and bone is also observed in adenomata, carcinomata, myxomata, cystomata, and sarcomata.

Myomata in their pure form occur but rarely in the testicle and epididymis, but it is more common to find newly formed muscular fibres, both striated and nonstriated, in mixed tumours. Trélat and Rindfleisch have reported myomata made up of nonstriated muscle (leiomyoma), but rhabdomyomata are more common.

Myxomata of the testicle and epididymis occur usually in the form of myxo-sarcomata, myxo-adenomata, and myxo-cystomata, while pure myxomata are rare. Myxomata, especially the mixed varieties, are usually semi-soft tumours of slow growth.

Sarcomata develop more frequently in the testicle than in the epididymis, but the latter usually becomes involved very early. All the different forms of sarcoma have been observed in the testicle and epididymis, especially spindle-celled sarcoma, soft round-celled sarcoma, giant-celled sarcoma, lympho-sarcoma, alveolar sarcoma, fibro-sarcoma, myxo-sarcoma, angiosarcoma, and melano-sarcoma. Cysto-sarcoma is also not uncommon, the cysts being formed either by dilatation of the seminiferous tubes or by degeneration of sarcomatous tissue. The tumours designated by some as medullary and alveolar sarcomata are regarded by Langhans and Kocher as epithelial carcinomata.

Sarcomata develop, as a rule, into very large tumours of a soft or a firm consistence and may occur at every age, although they are most

common in young individuals. A permanent cure is possible only by early castration, but in the majority of cases death occurs from metastasis.

Chloroma of the testicle and epididymis has been observed by Lücke. This is a light-green, grass-green, or brownish-green, round-celled sarcoma which develops almost exclusively in the periosteum of the facial and cranial bones, and gives rise to metastatic nodules of the same colour in various organs, particularly the liver and kidneys. Huber states that the green colour comes from small, strongly refractive granules in the cells which give the micro-chemical reaction of fat. These tumours are also characterized by the presence of an abnormally high percentage of chlorine.

Adenomata occur either in the pure form or as mixed tumours, and may give rise to growths of large size, such as that of a baby's head. Adenocystomata are more common than pure adenomata, and are characterized by the formation of cysts of variable size, due to cystic degeneration of the newly formed glandular tubes. Cystomata sometimes contain cartilage and newly formed muscular fibres. The change of an adenoma into a cystoma may be so complete that the entire testicle consists of but one cyst with fibrous walls (pure cystoma). Depending on the contents of the cysts, one may further distinguish a mucous cystoma and an atheromatous cystoma containing a material similar to that found in sebaceous cysts of the skin. Adenomata and cystomata develop usually in the rete testis and are most common in individuals between twenty and forty-five years of age. According to Eve, cysts of the testicle develop from the rudiments of the Wolffian body found in the hilum of the testicle. The prognosis is good. A permanent cure usually follows removal of the affected testicle, and recurrences or metastases are rare (Billroth, Féréol, Kocher). •

Besides the above independent cysts and cystic formations occurring in adenomata, cysts may develop in other tumours, including sarcomata, myxomata, and carcinomata, partly from the breaking down of tumour tissue and partly from the constriction of the tubes of the testicle and epididymis.

Dermoid cysts and teratomata have been but rarely found in the testicle and epididymis.

Other Cysts of the Testicle and Epididymis.—Retention cysts are frequently formed in the testicle and epididymis from the accumulation of secretion in the seminiferous tubes, particularly in the region of the vasa efferentia and the globus major. All these retention cysts which contain spermatozoa are called spermatoceles. Cysts may also arise from dilatation of the hydatid of Morgagni and of the upper end of Müller's duct. In the

latter case spermatozoa are found if a vas aberrans of the epididymis terminates blindly in the hydatid. The fluid contained in a spermatocele is in some cases perfectly clear and in others yellowish, greenish, or milky. Many spermatoceles remain small and cause no symptoms whatever. In the etiology of spermatoceles and cysts in general traumatism plays an important part. For a description of hydrocele spermatica see page 393. The latter is caused either by rupture of a spermatocele into the cavity of the tunica vaginalis or by communication between a vas aberrans and the latter.

Carcinomata of the testicle and epididymis form either soft, medullary, rapidly growing, or hard, slowly growing tumours. We have already mentioned that cysts may be formed by mucoid and colloid degeneration, and that the so-called colloid carcinoma may result in the same way. We have also seen that cartilage may be present in consequence of the growth of strayed cartilaginous germs. Epithelial carcinomata have also been observed in children in the first years of life. The prognosis of carcinoma of the testicle and epididymis is very dubious, and death usually takes place in about two years. The slower the growth, the better the prognosis, a scirrhus, for example, having been known to last for from eight to fifteen years. The earlier a carcinomatous testicle and epididymis is removed, the more likely is a permanent cure. The latter appears, however, to be rare; Kocher mentions three cases which were perfectly well four and a half, eight and a half, and ten and a half years after operation. Recurrences sometimes appear very late—for example, three to three and a half years after operation, in the inguinal and retroperitoneal glands. The inguinal glands should be removed in every case of carcinoma of the testicle, just as in carcinoma of the penis.

We lack space here to take up the very interesting subject of the etiology and development of tumours of the testicle and epididymis. Whoever is interested in this question will find it exhaustively treated by Kocher in the *Deutsche Chirurgie*.

§ 241. **Castration.**—Castration consists in separation of the testicle from its surrounding sheaths, isolation of the spermatic cord, ligation of the vessels of the latter, and division of the cord. For the topography of the testicle, epididymis, its enveloping membranes, and the spermatic cord, see page 390.

The technique of castration is as follows: The scrotum is grasped with the left hand above the testicle and the latter drawn downward between the thumb and forefinger so that the skin is put on the stretch. One then divides the skin, dartos, tunica vaginalis communis, and propria in a longitudinal direction until the serous surface of the testicle comes into view. In the case of very large tumours it is, of course,

impossible to draw the testicle downward, and one makes a free longitudinal incision from the external ring downward. In such cases the separate layers that cover the tumour can not be sharply distinguished from one another. After isolation of the testicle the latter is drawn out and the cord is now freed with the fingers, scissors, or a knife as far up as the external ring. In order to secure the cord and prevent the stump from slipping upward after its division it is transfixed, and after isolation of the vas deferens both halves are tied separately. The cord is then divided about one centimetre below the ligature. The vessels of the stump that are visible should then be tied and the ligature *en masse* can be removed. Secondary hæmorrhages frequently take place after separate ligation of the vessels of the cord because one may easily overlook a small branch, and for this reason it is better to tie off the whole cord as well, leaving out the vas deferens. I tie the cord in the vicinity of the external ring in three or four sections and then remove the preliminary ligature. Some have recommended leaving on the ligature *en masse* until the first dressing, or suturing the stump of the cord to the edges of the wound, in order to prevent secondary hæmorrhage, or be able to arrest it more easily in case it occurs. The vas deferens should not, as a rule, be tied, as severe pain and spasms have been known to result from its ligation. Besides the technique as described above, one may begin by tying off the cord first and then separate and remove the testicle.

The wound is either packed with sterilized iodoform gauze or closed by deep skin sutures, a drainage-tube being inserted for the first twenty-four hours. In suturing the scrotum one should be careful to avoid the formation of a cavity. The wound is covered with sterilized gauze and cotton and a suspensory may be applied.

§ 242. **Injuries and Diseases of the Seminal Vesicles.**—Before its junction with the seminal vesicles the vas deferens becomes dilated, forming the ampulla. The ampulla contains pouches, diverticula, and peculiar glands with club-shaped enlargements at the end. The seminal vesicles have essentially the same structure as the ampulla except that in the former the pouches and diverticula are larger and have more branches. Their length varies, according to Henle, from 4 to 8.5 centimetres, and their transverse diameter from 0.6 to 2.7 centimetres. They lie upon the outer surface of the fundus of the bladder in a nearly horizontal direction, curving slightly upward behind, and their outer borders rest on the upper border of the prostate. The excretory duct of the vas deferens and seminal vesicle, known as the ejaculatory duct, is formed in the region of the upper border of the prostate from junction of the vas deferens and seminal vesicle. The

physiological importance of the seminal vesicles is the same as that of the ampulla of the vas deferens, and consists in acting as a reservoir for the semen and making it thinner by the addition of a yellowish, albuminous viscid fluid derived from the above-mentioned glands. The seminal vesicles lie in the furrow between the bladder and prostate and to the outer side of its lateral lobes, and when normal can scarcely be felt with a finger in the rectum, but can easily be felt when enlarged, especially by counter-pressure in the iliac region.

Deformities of the Seminal Vesicles.—We mention particularly absence of the seminal vesicles with or without absence of the lower end of the vas deferens and the ejaculatory duct. In some cases the seminal vesicles and ejaculatory duct are fused into a single structure.

Injuries of the seminal vesicles sometimes occur—for example, in perineal lithotomy—and fistulæ of the seminal vesicles may ensue. In consequence of being wounded, the vesicles undergo cicatricial contraction.

Acute Inflammation of the Seminal Vesicles (Spermato-cystitis) is caused by injuries and inflammations of the same, especially gonorrhœa. Acute inflammation of these organs gives rise to more or less fever and to dragging pains in the region of the seminal vesicles which radiate toward the groin, the lumbar region, and the abdomen, and are increased by urination and defecation. Hæmospermia—i. e., painful evacuation of a reddish-brown (bloody) semen—is of diagnostic importance, but is not always present. Epididymitis is often present at the same time. On rectal examination, one can feel, especially when the bladder is full, a more or less marked, firm, or fluctuating swelling of one or both vesicles, while the prostate is not enlarged.

If the inflammation goes on to the formation of an abscess, the latter may rupture into the bladder or the peritoneal cavity. Fatal suppurative peritonitis has in several instances followed rupture of a suppurative spermato-cystitis. If the inflammation of the vesicles heals up there may be either complete return to the normal or more or less atrophy and contraction. It may also result in dilatation or the formation of cysts with or without obliteration of the excretory ducts. Obliteration of the excretory ducts of the seminal vesicles gives rise to aspermia, which is a not infrequent form of sterility in the male, following gonorrhœa.

In case of abscess, Kocher recommends making an incision under an anæsthetic through the rectum after stretching the sphincter. In cases which run a less acute course the treatment is symptomatic.

Concretions of the Seminal Vesicles result usually from thickening and calcification of the normal contents of the vesicles or of inflammatory products. These concretions usually contain spermatozoa. They can be most readily felt through the rectum by passing a searcher into the urethra. If they cause much disturbance, Kocher recommends crushing the concretions through the rectum after introducing a catheter or a sound into the urethra.

Among chronic inflammations of the seminal vesicles, tuberculosis is the most important, and is usually secondary to tubercular inflammation of some other portion of the genito-urinary tract. Tubercular seminal vesicles form hard or semi-soft cheesy nodules up to a walnut in size which can be

felt through the rectum. From a clinical standpoint the presence of suppuration and the danger of tubercular peritonitis and general miliary tuberculosis should be borne in mind. Kocher saw two typical cases of acute miliary tuberculosis following tubercular inflammation of the seminal vesicles. Particularly in primary tuberculosis of the vesicles, and also in coexisting tuberculosis of the testicle and epididymis, extirpation of the seminal vesicles may come into consideration and may be performed through the perinaeum by the method of Dittel and Zuckerkandl, or through the sacral region with or without resection of the coccyx (see page 432).

Tumours of the Seminal Vesicles.—Primary tumours of the seminal vesicles are very rare. Labbé reported a case of primary carcinoma. Secondary carcinoma is more common, and follows usually carcinoma of the prostate, bladder, and rectum. Zahn described a primary sarcoma.

CHAPTER XXVI.

INJURIES AND DISEASES OF THE PROSTATE AND COWPER'S GLANDS.

Anatomy and physiology of the prostate.—Examination of the prostate.—Deformities.—Injuries.—Acute inflammation.—Prostatic abscesses.—Periprostatis phlegmonosa.—Chronic inflammations.—Prostatorrhœa.—Tuberculosis.—Hypertrophy of the prostate.—Atrophy of the prostate.—Prostatic calculi.—Tumours.—Operative exposure of the prostate.

Diseases of Cowper's glands.

Appendix: Functional disturbances and neuroses of the male sexual organs.—Impotence.—Sterility in the male.—Aspermia.—Spermatorrhœa and other anomalies in the evacuation of the semen.

§ 243. **Anatomy and Physiology of the Prostate.**—The prostate is a chestnut-shaped organ with rounded-off borders which surrounds the neck of the bladder and the prostatic portion of the urethra. Its anterior surface is directed toward the anterior wall of the pelvis and connected with the symphysis by means of the pubo-prostatic ligament, while its posterior surface is attached to the anterior rectal wall by dense connective tissue. Its apex, which is directed forward and downward, rests upon the triangular ligament. The prostate is very small in children, and begins to develop rapidly at the time of puberty. In adults and late in life the size of the prostate shows marked individual variations. The average transverse diameter in healthy persons is from 32 to 45 millimetres, the longitudinal diameter 25 to 35 millimetres, and the greatest antero-posterior diameter 14 to 22 millimetres (Henle); the average weight is 16 to 17 grammes. The prostate contains a number of acinous glands and, what is of great surgical importance, the internal sphincter, made up of involuntary muscular fibres, and the external sphincter, which is a voluntary muscle. Besides the urethra, it also incloses the ejaculatory ducts, the tissue of the verumontanum, and the prostatic sinus (uterus masculinus), which is a remnant of Müller's duct. The urethra divides the prostate into two lateral lobes. The so-called median lobe corresponds to the verumontanum and the prostatic sinus. These three lobes can be distinguished only when the prostate is hypertrophied. Many authors doubt the existence of the median lobe, and Socin is right in calling attention to the fact that this

lobe, which under pathological conditions becomes enlarged and forms an independent tumour, lies not behind but in front of the ejaculatory ducts or the vesical orifice of the urethra.

The physiological importance of the prostate has not yet been fully established. It is supposed to render thinner the semen that is discharged from the ampulla and seminal vesicles during coitus. The prostate is also intimately connected with the act of erection, and it furnishes the mucous fluid which escapes from the meatus after prolonged erections.

Examination or palpation of the prostate is performed by the introduction of the right index finger into the rectum, while at the same time a catheter or sound is passed into the prostatic urethra. In this way it is possible to determine approximately the length and thickness of the prostate. If the patient has a very lax abdominal wall one can, in exceptional cases, feel the prostate by deep palpation above the symphysis.

The diseases of the prostate are of great clinical importance, and are a frequent cause of disturbances in urination among elderly persons. Retention of urine in consequence of hypertrophy of the prostate favours the formation of calculi. It is also important to know that the point of a catheter may lodge in a prostatic sinus which is congenitally large or has been dilated by disease.

§ 244. **Congenital Deformities of the Prostate.**—Complete absence of the prostate occurs only in case of serious malformation of the whole genito-urinary tract.

The size of the prostate is, as already mentioned, subject to great individual variations.

In a case of congenital fistula of the penis at the edge of the pubic hairs, the fistulous tract led down to the strayed anterior middle portion of the prostate (prostate accessoria, Luschka; see also page 344).

Englisch described a case of retention cyst of the prostatic sinus from closure of the same, with secondary retention of urine. The congenital and acquired cysts in the cellular tissue between the prostate and rectum also develop, according to Englisch, from the blind pouchlike termination of the prostatic sinus. These latter cysts, however, usually remain small and cause no disturbances.

Other partly congenital and partly acquired cysts, situated between the prostate or posterior wall of the bladder and the rectum, develop, according to Englisch, from the incompletely obliterated Müllerian duct. They are situated in the median line, while the cysts that are more laterally situated are formed from remains of the Wolffian body. These last two varieties of cysts may gradually attain a large size, and later in life interfere more or less with urination and defecation. Among other cysts in the vicinity of the prostate which result from disturbances in development, the dermoids should be mentioned. All these cysts in the region of the prostate may be mistaken

for other cysts, such as echinococcus cysts or dilatations of the seminal vesicles and the vas deferens, or with tumours of the prostate, and their diagnosis will hence often be difficult. One must also bear in mind the possibility of a diverticulum of the bladder. In order to make the differential diagnosis between a prostatic cyst and the latter, Socin recommends making a rectal examination after previous evacuation of the bladder. A diverticulum of the bladder can be emptied more or less completely by pressure from within the rectum, while a cyst remains unchanged. One might also make an exploratory puncture from within the rectum in order to make sure of the diagnosis.

In the treatment of prostatic cysts, in case they interfere with urination and defecation, Socin recommends puncture of the same with a trocar or incision from the rectum. Socin is right in warning against the injection of antiseptic solutions or drainage, because by these means suppuration and fatal peritonitis could result. Bryant operated successfully through the perinæum, and prolonged the perineal incision into the rectum.

§ 245. **Injuries of the Prostate.**—Injuries of the prostate are rare, and occur usually in perineal lithotomy and from the unskilful use of a lithotrite or a catheter ("false passage"). We have already mentioned the fact that the catheter may be caught in a dilated prostatic sinus. Congenital folds of skin in the form of valves also occur at the site of the verumontanum which favour a false passage or injury of the prostate. Incised wounds of the prostate heal as a rule very well, while contused wounds may easily give rise to inflammation and sloughing of the pelvic cellular tissue and peritonitis, especially if the fibrous capsule of the prostate is divided. In performing perineal section, therefore, and in all operations in the vicinity of the prostate, all contusion and laceration of the prostate and its surroundings are to be carefully avoided. Extravasation of urine resulting, for example, from a false passage within the prostate, with coexisting cystitis, gives rise only too easily to extensive inflammation and sloughing in case the perinæum is not promptly incised.

The treatment of injuries of the prostate follows, generally speaking, the same principle as that of ruptures of the urethra (see page 346). Here also the main indication is to prevent or remedy retention and extravasation of urine, and this is best secured by perineal section and drainage (see also page 421, Treatment of Acute Inflammation of the Prostate).

§ 246. **Inflammations of the Prostate.**—Acute inflammation of the prostate (acute prostatitis) is rare, and is the result of traumatisms or of inflammation of the neighbouring organs, especially gonorrhœal urethritis, which spreads to the excretory ducts of the prostatic glands. Suppurative prostatitis may also follow phlebitis and periphlebitis of the pelvic cellular tissue, bedsores, pyæmia, etc.

The symptoms of an acute prostatitis vary with the degree of the inflammation. It usually begins with fever and not infrequently with a chill, and the patient complains of pain on defecation, urination, and even when sitting down, and a constant feeling of weight and heat in the region of the bladder. In cases with marked swelling of the prostate there is severe rectal tenesmus and sometimes retention of urine. On palpation of the prostate through the anterior wall of the rectum it is found to be enlarged, very painful, and feels hot. The increase in the size of the prostate is very variable. The introduction of a catheter, which may be necessary in case of retention of urine, is a very painful procedure, and an anæsthetic is often required. In very acute cases, especially when there is coexisting gonorrhœa, the symptoms of acute prostatitis are so typical that the diagnosis is easy. In subacute and more or less latent cases, as in pyæmia, for example, the diagnosis is more difficult.

The outcome of an acute prostatitis depends upon the severity and the location of the inflammation. It is either followed by a complete return to the normal, or the acute inflammation becomes a chronic one with a prolonged course. Suppuration takes place with comparative frequency, and usually several small abscesses are formed which may rupture into the urethra or the rectum. Perforation of the abscesses is usually followed by a marked improvement in all the symptoms. The most dangerous form is the diffuse suppuration of the prostate, which may spread to the pelvic cellular tissue and the peritonæum and end fatally from peritonitis. The best thing that can happen in such cases is for the abscess to rupture into the rectum or be opened from here. In other cases the pus burrows toward the perinæum or the outer or inner side of the thigh. In all these cases combined examination from the rectum and perinæum is of great importance in finding the pus focus. Even in a diffuse phlegmon evacuation of the pus may cause rapid healing, but in many cases, however, the course is very protracted, particularly when there are fistulæ in the perinæum, thigh, and rectum. If a prostatic abscess ruptures simultaneously into the urethra and rectum, a urethro-rectal fistula results. Death takes place in case of a diffuse phlegmon in the region of the prostate from peritonitis, sepsis, or pyæmia. According to Segond, the mortality of prostatic abscesses is twenty per cent, and the mortality of the cases that do not receive surgical treatment twenty-five to thirty-five per cent. Spontaneous healing of a prostatic abscess from inspissation of the pus to a calcareous mass is extremely rare (Dittel).

Treatment of Acute Prostatitis.—At the outset of the inflammation the patient should be kept absolutely quiet in bed, cathartics should be

prescribed, and a leech or ice applied to the perinæum. The latter is, however, of but slight efficacy, and in case there is severe pain hot sitz baths and poultices give more relief, by causing hyperæmia of the skin, and in this way diminishing the engorgement of the deeper parts. For the pain one may also employ suppositories containing morphine, opium, or belladonna, opium enemata, or rectal injections of a ten-per-cent ichthyol solution two or three times a day. As a beverage some form of carbonated water containing sodium is to be preferred. In case a prostatic abscess is formed, one should not await its spontaneous rupture into the urethra, but incise it as soon as possible either by the sacral route or through the perinæum or the rectum. If on rectal examination fluctuation can be made out in the prostate or its vicinity, one can dilate the sphincter under an anæsthetic, introduce a Simon vaginal speculum, and in this way expose the region of the prostate sufficiently to make a free incision for evacuation of the pus. All hæmorrhage should be carefully arrested. Although a fistula results only in exceptional cases from an incision through the rectum, I consider it a better procedure to expose the prostate from the perinæum or by the sacral route as described on page 432. If in a prostatic abscess fistulæ are already present, they should be correspondingly slit open. If there is retention of urine, a catheter should be cautiously introduced into the bladder, by which means spontaneous discharge of the abscess into the urethra may be hastened.

Chronic Inflammations of the prostate are more common than the acute; they either result from the latter, or begin gradually as such. The most frequent chronic inflammation of the prostate is the one which leads to hypertrophy of the organ (see § 247, page 424).

Chronic Catarrhal Inflammation of the Prostate (Prostatorrhœa) is characterized by the formation of a cloudy, viscous, mucous fluid which escapes from the urethra, mainly during defecation, from the pressure of hard fæcal masses upon the prostate. It is most common in chronic gonorrhœa and in masturbators. This hypersecretion of the prostate may run its course without painful enlargement of the gland, and can then be regarded as a sympathetic irritation of the same, or the prostate may be distinctly enlarged and painful on pressure. Prostatorrhœa is often mistaken for spermatorrhœa, but the correct diagnosis can be made from microscopic examination of the secretion. Our knowledge of the composition of the normal secretion of the prostate is, however, still very incomplete. It is characterized sometimes by the presence of concentric amyloid bodies. It is also of diagnostic importance that in prostatorrhœa the prostate can be emptied by pressure from within the rectum.

The treatment of prostatorrhœa is directed first of all against its cause. Besides this, a corresponding local treatment should be employed. Socin recommends for this purpose Garreau's *sonde à piston*, a silver catheter

which is open at its end and in which a tight-closing piston moves (Fig. 580). Dittel's *porte-remède* is also useful, as well as Lallemand's applicator (see Figs. 563 and 565, page 357). By means of the latter instrument the proper materials are applied in solution, as an ointment, or in substance, to the prostatic ure-

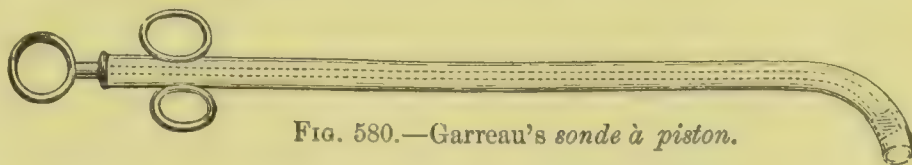


FIG. 580.—Garreau's *sonde à piston*.

thra, as has already been described for chronic gonorrhœa (page 357). The opening of Garreau's and Dittel's applicators is closed with wax after the material to be used has been placed in the instrument. Socin recommends a solution containing one part iodine, four parts iodide of potassium, and one hundred parts water; and, moreover, glycerin ointments in a semifluid form. Solutions of nitrate of silver (one half to ten per cent), or in very obstinate cases cauterization with the nitrate-of-silver stick, are particularly efficacious. The insertion of fine silver-nitrate sticks or bismuth or iodoform pencils should, in obstinate cases, be repeated every six or ten days. I frequently employ irrigation of the prostatic urethra with bichloride (1:10,000–15,000) by means of a silver catheter shaped like a stone-searcher, the posterior third of which is provided with numerous holes. If the local treatment causes much reaction, warm sitz baths are used. Of mineral springs, Carlsbad and the warm sulphur springs are the favourites. In many cases good food, good air, exercise, and favourable hygienic surroundings produce very favourable results.

For the course and treatment of chronic suppurative prostatitis see page 421. It may be mentioned here that glanders is sometimes complicated by chronic suppurative inflammation of the prostate.

Tuberculosis of the Prostate.—Primary tubercular inflammation of the prostate is very rare, and even secondary tubercular prostatitis following tubercular inflammation of neighbouring portions of the genito-urinary tract is not common. Prostatic tuberculosis runs its course with the formation of caseous foci and disintegration of the gland, which may result in perforation into the urethra, the rectum, the bladder, and the peritoneal cavity. The disease usually attacks young individuals. Out of twenty-six patients, thirteen were under thirty years of age (Socin). Its symptoms are mainly those of a chronic prostatitis. For the diagnosis the presence of coexisting tuberculosis of other organs, particularly the genito-urinary tract, is important. Constant dribbling of urine may occur in case of paresis of the sphincter, which is infiltrated with a tubercular deposit, and in such cases great caution must be exercised in passing a catheter. Socin saw the latter followed by acute sloughing.

The treatment of tubercular prostatitis consists in a proper constitutional treatment and in a symptomatic local treatment. In suitable cases the prostate may be exposed by the method described on page 432, the tubercular foci thoroughly scraped out and cauterized with the thermo-cautery.

In rare cases chronic suppuration has been caused by actinomycosis. The treatment consists here in the administration of iodide of potassium,

which has a favourable influence upon its course, and in performing, in suitable cases, an operation through the perineum or the sacral region (see page 432).

Chronic suppuration of the prostate may give rise to cicatricial contraction of the prostate and periprostatic tissue. This contraction may extend to the vicinity and cause more or less marked stricture of the rectum (Kirmisson, Desnos).

§ 247. **Hypertrophy of the Prostate.**—Enlargement of the prostate is sometimes general, involving the whole gland, and sometimes only partial.

Anatomical Changes in Hypertrophy of the Prostate.—In case of general hypertrophy of the prostate, which is by far the more common, the gland is either symmetrically enlarged or single portions project more than others. The consistence of the hypertrophied prostate is sometimes hard and sometimes soft. Socin is right in combating the view that hypertrophy of the

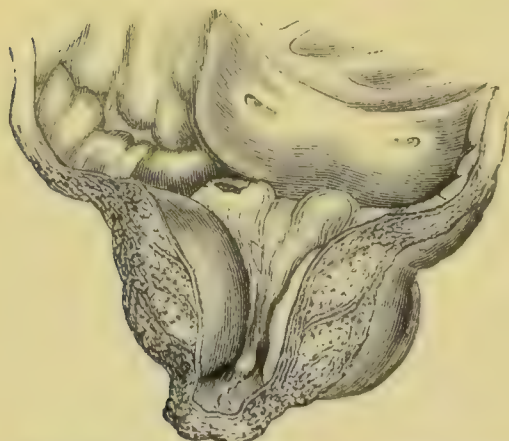


FIG. 581.—General diffuse hypertrophy of the prostate (Socin).

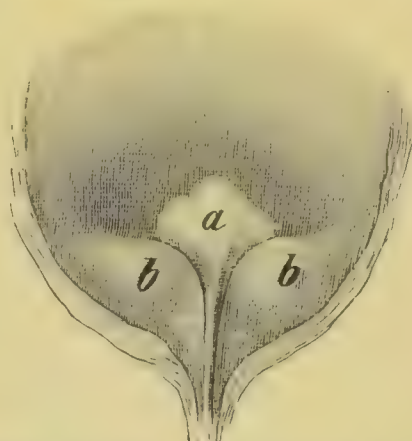


FIG. 582.—Nodular hypertrophy of the prostate: *a*, middle lobe; *b*, lateral lobes.

middle lobe is the more common form; and we have already stated that the normal non-hypertrophied prostate does not possess a middle lobe. The external appearance of a hypertrophied prostate is very variable. The hypertrophy is usually caused by an increase in the fibrous and muscular elements of the organ, while the glandular tissue is either unchanged, atrophic, or the seat of cystic degeneration. In some cases, however, there is a hyperplasia of glandular tissue, just as in an adenoma. Fig. 581 represents a diffuse and Fig. 582 a more nodular hypertrophy of the gland. Both forms of hypertrophy are to be regarded as tumours, and in fact the circumscribed nodular form is sometimes a true fibroma or fibro-myoma.

The most important anatomical changes which are brought about by hypertrophy of the prostate affect the urethra and bladder. The neck of the bladder is pushed up, as it were, by the enlarged prostate, while the fundus becomes dilated behind and below in the form of a sac. The urine easily collects in this pouch both from mechanical reasons and because the detrusor muscle performs its function only imperfectly on account of its degeneration. The entire muscular coat of the bladder sometimes undergoes ex-

tensive fibrous degeneration. The vesical opening of the urethra is completely surrounded by the dense hypertrophied tissue of the prostate.

The changes in the prostatic urethra are very characteristic. The urethra is lengthened and considerably dilated in its antero-posterior diameter. The direction taken by the prostatic portion is changed, its curvature being increased. These changes in the form and direction of the urethra become more marked with the increasing hypertrophy of the prostate, and it can be readily seen that in the more severe cases catheterization is only possible with abnormally long and very much curved catheters. In advanced cases the prostatic urethra is practically bent on itself. In partial lateral hypertrophy the urethra is pushed toward the side. The neck of the bladder is often surrounded by firm nodular masses which project in front of the internal urethral orifice and interfere more or less with evacuation of the urine. Concentric hypertrophy of the muscular coat of the bladder without hypertrophy of the prostate may result in the formation of a transverse ridge in front of the urethral orifice, which in the same way causes difficulty in urination.

The condition of the internal sphincter is also of great importance as regards evacuation of the urine in hypertrophy of the prostate. The internal sphincter ceases to form a continuous ring that is capable of performing its function, partly because it is so much stretched and partly because it is so permeated and displaced by the newly formed connective tissue. In marked cases of circular hypertrophy these changes may be such that a real sphincter can no longer be found. The muscular closure of the bladder then gradually becomes more and more imperfect, and finally there is merely a valvelike closure of the urethral orifice. Obliteration of the ejaculatory ducts is furthermore a not infrequent sequel of hypertrophy of the prostate, giving rise to aspermatism (Socin).

The above changes in the bladder, neck of the bladder, and the prostatic urethra lead to hindrances in the evacuation of the urine, and this in turn to dilatation of the bladder with hypertrophy of its muscular coat. The dilatation of the bladder may involve the ureters and pelvis of the kidney and give rise to hydronephrosis with secondary atrophy of the substance of the kidney. Retention of urine and frequent catheterization, particularly with unclean instruments, give rise to cystitis, formation of stone, and to false passages with all their consequences.

The direct causes of hypertrophy of the prostate are almost entirely unknown. It is not a true inflammation, although it is favored by inflammatory processes in the bladder and urethra and by venous congestion of the pelvic viscera. This explains why one finds so frequently in hypertrophy of the prostate varicose dilatation of the veins of the bladder and of the prostatic plexus. It is in reality a senile process of tumour formation, which almost always occurs in individuals over fifty or fifty-five years of age and is the counterpart in many respects of fibroids of the uterus (White). Guyon considers arterio-sclerosis of the genito-urinary organs of great etiological importance, while Harrison looks upon hypertrophy of the prostate as a secondary condition due to overwork of the muscular coat, which is in turn the result of increasing senile atony of the bladder with dilatation of the same below and posteriorly.

Symptoms and Clinical Course of Hypertrophy of the Prostate.—The symptoms of hypertrophy of the prostate are very variable; in a large number of cases they are entirely absent, while in others the disturbances are slight and the condition is accidentally discovered at the autopsy. The most important symptoms consist in disturbances in the evacuation of urine (dysuria, "*prostatisme vésical*," Guyon), which are present in varying degree and are due to the above changes in the bladder, neck of the bladder, and prostatic urethra. This defective evacuation of urine is sometimes caused by displacement of the urethral orifice by tumour nodules or by a pouch-like condition of the bladder wall, and sometimes there is partial incontinence due to imperfect closure of the bladder from overdistention or fibrous degeneration of the internal and external sphincter muscles and of the muscular wall in general. This fibrous degeneration of the muscular wall occurs among elderly individuals, even without hypertrophy of the prostate, and gives rise to saccular dilatations or diverticula, even when the prostate is only slightly or not at all enlarged. The chief symptom at the outset is, in some cases, interference with urination and in others incontinence. In severe cases the evacuation of urine may be so interfered with that it can be forced out only in drops and with much straining. Many patients can urinate best when bending over or lying on their abdomen or side. If the action of the sphincter is imperfect the patient has to urinate frequently and involuntarily, and if the sphincter is more or less destroyed and does not perform its function the incontinence of retention ensues—i. e., the distended bladder runs over. In every case of marked hypertrophy of the prostate sudden retention of urine may take place, in consequence of any condition which increases the obstruction at the neck of the bladder—such, for example, as inflammatory œdema, coitus, catheterization, voluntary retention of urine, etc. If in the latter case the bladder is too full, a sort of valve is formed at the neck of the bladder by approximation of the folds of mucous membrane, and the urethra becomes flexed. In advanced cases patients can no longer evacuate their urine themselves, and have to be catheterized at regular intervals.

The clinical picture of hypertrophy of the prostate includes, furthermore, the above-mentioned consequences of retention and decomposition of the urine, such as cystitis, the tendency to the formation of calculi, dilatation and diverticulum of the bladder, dilatation of the ureters and the pelvis of the kidney, nephritis, etc. The cystitis is often severe, particularly when the patients catheterize themselves with unclean catheters. Unskilful catheterization frequently gives rise to the formation of false passages, and in consequence of these, suppu-

ration and sloughing of the prostate. Death is due in the most marked cases of hypertrophy of the prostate to increasing marasmus, cystitis, nephritis, or to more or less sudden phlegmonous inflammations, caused, for example, by injuries of the prostatic urethra from catheterization.

In the diagnosis of hypertrophy of the prostate the above-mentioned group of symptoms and the age of the patient are important. The diagnosis can be established beyond a doubt by palpating the prostate through the rectum and introducing a catheter into the bladder. Catheterization should be performed very cautiously, and only by one skilled in the use of the instrument.

Treatment of Hypertrophy of the Prostate.—Heine in particular has recommended parenchymatous injections into the prostate at intervals of from eight to fourteen days. The patient lies on his side, and under the guidance of the left forefinger a long, curved aspirating needle, attached to a hypodermic syringe, is inserted into the prostate, preferably its lateral portion, where one can most easily avoid wounding the vessels. A whole syringe-ful of an iodine solution (60 water, 30 tincture of iodine, and 2 iodide of potassium) is then injected. Ergotin and absolute alcohol have also been used. These parenchymatous injections have resulted favourably in a number of cases, but they are not without danger, as abscesses have been known to follow. Forceful dilatation of the prostatic urethra and the vesical orifice of the urethra, by means of large sounds, is of only temporary benefit.

Operative treatment of hypertrophy of the prostate by division, or usually partial excision, of the gland (prostatomy and prostatectomy) has been tried in a large number of cases. Internal urethrotomy has also been performed in the same way as for stricture of the urethra, or the prostatic urethra dilated by instruments similar to a lithotrite (Mercier). All operations performed from within the urethra are, however, very uncertain, and Socin is right in saying that the success obtained is not at all proportionate to the danger involved. Robertson performs prostatomy from within the rectum: with the left forefinger in the rectum as a guide, the prostate is incised through the rectal mucous membrane, and this incision is deepened with the finger until the prostate is divided into two halves. Bottini recommends removal of the hypertrophied portion with the galvano-cautery, while Biedert, Casper, and others employ galvano-puncture (electrolysis). A platinum needle, attached to the negative pole and insulated up to within one centimetre and a half from its point, is carried into the rectum and inserted to the depth of one centimetre and a half into the prostate, and the current allowed to act for from two to five minutes (two ele-

ments or ten milliamperes gradually increased to eighteen elements or twenty-five milliamperes). The needle is then partially withdrawn and inserted through the same puncture opening into another part of the prostate, whereupon the current is again allowed to work for from two to five minutes. The sittings are repeated at proper intervals from ten to twenty times. Watson, Landerer, and Schmidt have of late performed partial excision of the enlarged prostate through the perinæum. The best plan is to expose the prostate by the method of Dittel and Zuckerkindl (see Fig. 586, page 432, and Fig. 587, page 433), or by the sacral route (page 432), and then remove the prostate as completely as possible with the knife or thermo-cautery. Dittel devised the following method of lateral prostatectomy for the removal of the lateral portions of a hypertrophied prostate: An incision is made from the tip of the coccyx toward the centre of the external sphincter, and then around this in the form of a curve to the perineal rhapshe; the ischio-rectal fossa is then opened on both sides, the lateral lobes of the prostate exposed by separating the previously tamponed rectum from them by blunt dissection and a flap-shaped or cuneiform piece excised from each half. Küster has employed this method in three cases with good success. Watson removes the prostate through the perinæum after dividing the membranous urethra in the median line. Belfield, Kümmell, Trendelenburg, Robson, the author, and others have in severe cases exposed the neck of the bladder by suprapubic cystotomy and then removed the hypertrophied prostate in the region of the vesical orifice of the urethra, thus making urination possible.

The advantages of the radical operation for prostatic hypertrophy—i. e., extirpation of the prostate—seem to me very questionable, as in the majority of cases the functional and anatomical disturbances on the part of the bladder can not be remedied in this way. On the other hand, double castration, as recommended by White, of Philadelphia, has given very good results as regards both the local disturbances and the general condition of the patient. White has reported 111 cases operated on in this way, partly by himself and partly by other surgeons. In 87.2 per cent of the cases gradual contraction of the prostate took place in a comparatively short time, and the other symptoms improved. Death occurred in twenty cases, not as a result of the operation, but in consequence of complications, such as uræmia. Bier tied the internal iliac artery on both sides in three cases, and with very good results.

The main indication in the therapy of hypertrophy of the prostate is the treatment of the coexisting cystitis and retention of urine. If these are present one should determine the shape and size of the prostate by rectal examination, and then try to pass a catheter. I prefer large, aseptic, well-

oiled soft-rubber catheters or elastic Mercier catheters (Fig. 583, I), with elevation it may be of the pelvis and simultaneous palpation of the urethra or prostate from the rectum. Mercier's catheter *bicoudé* is often very useful, or the English web catheters. It is often necessary to give these English catheters a different curve to suit special cases (Fig. 584). For this purpose the catheter is softened in warm water, a stylet with the proper curve inserted, and then it is placed in cold water. If a flexible catheter can not be introduced, one should try a silver catheter of large size and of extra length and provided with a Mercier curve. On entering the prostatic urethra one must often lower the metallic catheter or give it a lateral movement in order to get into the bladder. The most dangerous instruments in hypertrophy of the prostate are the small metallic catheters which frequently cause a false passage. Metallic catheters, in consequence of fixation of the prostate and the peculiar curve of the prostatic urethra, are in my opinion less desirable and certainly less pleasant for the patient than elastic catheters. Other surgeons hold a different view; König, for example, prefers long metallic catheters of large caliber. If the amount of hypertrophy is small and the patient is an old man with saccular dilatation of the bladder posteriorly and below, a large metallic catheter is then easy to introduce. Only aseptic catheters should, of course, be employed.

If a false passage has been made one should try to determine the location of the injury by rectal examination while a catheter is being introduced. In hypertrophy of the prostate the false passage

is almost always in the vicinity of the bladder. One should here also employ a soft-rubber, Mercier, or metallic catheter with Mercier's curve, and if the instrument enters the false passage it should be partially withdrawn and an attempt made to pass it along the anterior wall of the urethra into the bladder. In difficult cases Mercier's method is often useful. A large-sized tin catheter with a solid tip and a transverse bevelled eye is employed, and into



FIG. 583.—I, Mercier's catheter; II, Mercier's catheter *bicoudé* for hypertrophy of the prostate.

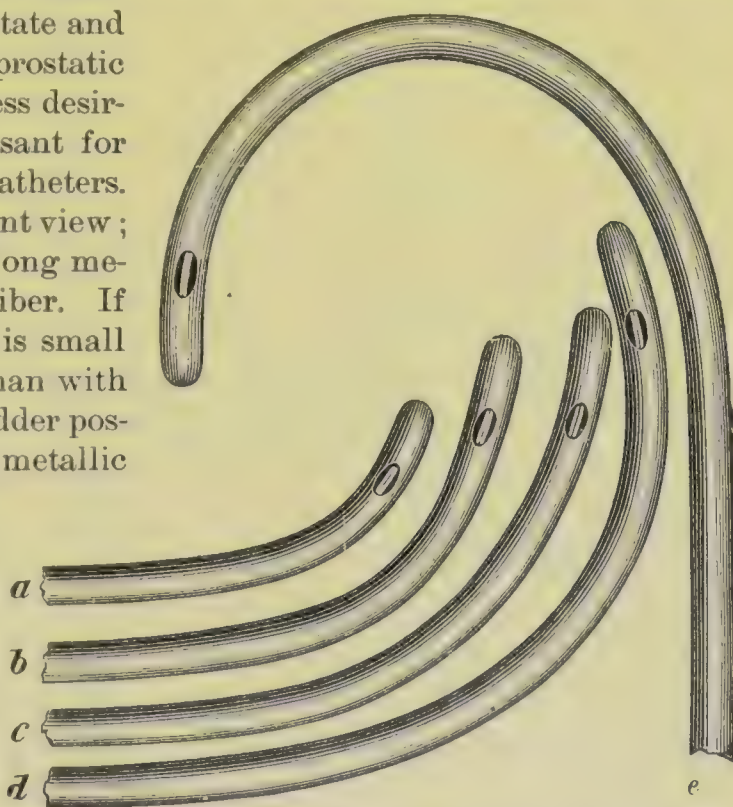


FIG. 584.—English catheters with different curves for hypertrophy of the prostate: *a*, slightest curve; *e*, greatest curve.

this an elastic catheter is inserted so that it can be pushed out through the eye. When the tip of the metallic catheter has become caught in the false passage it is withdrawn a little and the elastic catheter pushed forward, whereupon it glides past the false passage which is covered by the metallic catheter and enters the bladder (Fig. 585). In the worst cases the catheter should be allowed to remain in the bladder as a permanent catheter (see page 278).

If it is impossible in case of retention of urine to introduce a catheter into the bladder one should perform either puncture of the bladder above the symphysis (see § 210, page 304), suprapubic cystotomy (see § 214, page 319), or external urethrotomy (§ 223, page 324). Suprapubic puncture may also be performed with Dieulafoy's aspirator and a very small, hollow needle. The views of different surgeons are divided as regards the value of external urethrotomy for hypertrophy of the prostate; it may, under certain circumstances, be very difficult and not without danger, and for this reason I employ it only in exceptional cases.

M. Schmidt speaks very highly of Harrison's method of performing urethrotomy or prostatotomy, and has employed it in a large number of cases with the very best success. He performs it as follows: The membranous urethra is first opened, the finger

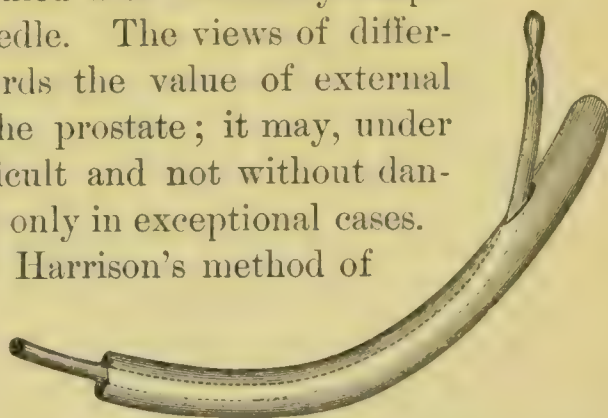


FIG. 585.—Mercier's method of introducing a catheter in case of the presence of a false passage.

is introduced into the prostatic urethra, which is then divided in the median line either by an incision or bluntly with the finger, and a large drainage-tube is introduced into the bladder and allowed to remain for from six to twelve weeks, until a catheter can be easily passed into the bladder in the usual way or the urine is evacuated normally. Suprapubic cystotomy is, in my opinion, to be preferred in severe cases both to urethrotomy and puncture of the bladder, as one can in this way remove a portion of the hypertrophied prostate and cure the cystitis. In one case of hypertrophy of the prostate in which urination was impossible in spite of a previous suprapubic cystotomy and external urethrotomy with removal of portions of the tumour in the vicinity of the neck of the bladder with the thermo-cautery, I made a urinary fistula above the symphysis by means of suprapubic puncture. The orifice of such urinary fistulae is kept closed by means of the abdominal muscles, and the patient can without difficulty evacuate his bladder three or four times a day by means of an elastic catheter.

Other complications occurring with hypertrophy of the prostate, especially cystitis, are treated in the usual way (see Treatment of Dis-

eases of the Bladder, Kidney, etc.). It is important that patients with prostatic enlargement should avoid all excesses in eating and drinking.

Atrophy of the Prostate.—Atrophy of the prostate, which occurs as a senile manifestation in general anæmia and marasmus, sometimes causes, in consequence of fibrous degeneration of the muscular wall of the bladder, the same disturbances as hypertrophy of the prostate (Englisch). Dittel observed incontinence as the result of coexisting atrophy of the sphincter. It is, moreover, of practical importance that occasionally in atrophy of the bladder the excretory ducts of the prostatic glands are so dilated that bougies and catheters are easily caught in the same and their introduction into the bladder thus prevented.

Concretions in the Prostate; Prostatic Stone.—The prostate of adults always contains the corpora amylacea, which are usually brown or almost black in colour. They are sometimes of microscopic size and sometimes as large as a millet seed, homogeneous in structure or stratified, and often contain a special nucleus. They give the iodine reaction that is characteristic of amyloid, and probably arise from hyaline degeneration of dead cells of the glandular ducts, about which as a nucleus an albuminous substance is deposited, which is derived from the secretion of the glands (Stilling). By a process of calcification and the formation of a common covering about a number of these corpora amylacea large concretions may be formed. In very marked cases the prostate is transformed into a thin-walled sac filled with stones, which gives a peculiar sensation of crepitation on pressure through the rectum. Prostatic stones give rise as a rule to no special symptoms and require no treatment. They sometimes enter the urethra or bladder, where they remain or pass off with the urine, causing some pain. The formation of concretions is sometimes complicated by suppuration, and the pus and calculi may break through into the rectum, urethra, or bladder. The stones that develop within the prostate are to be distinguished from those that sometimes enter the prostate from the bladder.

§ 248. **Tumours of the Prostate.**—We have already mentioned fibromata and fibromyomata in connection with nodular hypertrophy of the prostate as well as the glandular hyperplasia, which can be regarded as an adenoma. In describing hypertrophy of the prostate we stated that it is to be looked upon as a senile process of tumour formation. A description of the cysts in the vicinity of the prostate, which are caused mainly by anomalies of development, will be found on page 419. Of other tumours of the prostate, the sarcoma and carcinoma are particularly important, both of which are rare and may be primary or secondary. Sarcoma occurs mainly in young individuals, and, in fact, half of the cases that have been reported were in children. This variety of tumour, which enlarges sometimes toward the urethra and sometimes toward the rectum, usually causes death within six months (Barth).

The symptoms of a malignant tumour of the prostate, particularly a destructive carcinoma, consist mainly of mechanical interference with

urination, severe pain, hæmorrhages, fistulous tracts in the vicinity, and disturbances in the general condition, which usually take place early in the disease. Carcinomata of the prostate give rise to extensive metastases, especially in the bones.

The diagnosis of a tumour of the prostate is not always easy, and the differential diagnosis has to be made in some cases from hypertrophy of the prostate, tuberculosis, vesical calculi, cystitis, and tumours of the bladder. Examination *per rectum* and bimanual examination under an anæsthetic with the aid of a catheter may be necessary to make the diagnosis. Pieces of tumour are sometimes evacuated with the urine or by means of a catheter, and microscopic examination of these will determine the nature of the tumour. In malignant, destructive tumours the pain is very severe, and is continuous or occurs only during urination and defecation, and there may be enlargement of the lymph glands, ulcerative processes, etc.

Treatment of Tumours of the Prostate.—Billroth removed successfully a carcinoma of the prostate in a man thirty years of age which had an ulcerated surface within the bladder. The patient died one year and two months later from a recurrence. Demarquay removed a carcinoma of the prostate in two cases and Czerny in three cases, without permanent success. The results that have thus far been obtained by the operative treatment of malignant tumours of the bladder are very poor, as the patients as a rule come to operation too late.

In the extirpation of tumours of the prostate one may divide the perinæum and the anterior rectal wall in the line of the rhaphe, or,

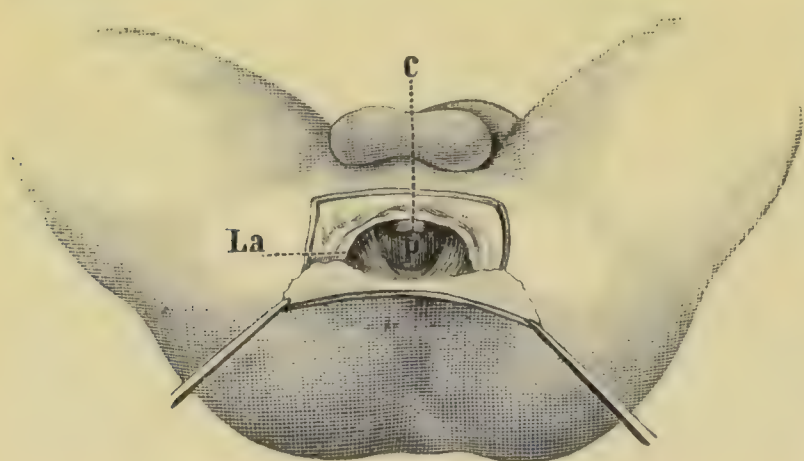


FIG. 586.—Exposure of the prostate after Dittel and Zuckerkandl: P, prostate; La, levator ani; C, Cowper's glands.

better, dissect up the latter, and, after exposing the prostate, divide the same in the median line down to the urethra, which contains a staff (Küchler). One may also divide the anus and rectum anteriorly and posteriorly and resect the coccyx (Socin, the author). The perito-

næum is detached without tearing it, and the prostate or the tumour can be excised without injuring the urethra. The prostate and seminal vesicles may also be exposed by means of a posterior longitudinal incision alongside the sacrum, as recommended by Rydygier. The skin in-

cision begins laterally near the gluteal fold in the furrow between the edge of the sacrum and the glutæus maximus, two fingers' breadth beneath the posterior superior spine of the ilium, and passes downward to the median line above the tip of the coccyx. One then makes his way inward to the prostate, passing by the rectum and resecting, if necessary, the coccyx either temporarily or permanently.

Zuckerkindl has recently recommended the perineal route for exposing the prostate by a method very similar to Dittel's older method. The patient lies in the lithotomy position. A flap is then formed by making a transverse incision six centimetres in length, three centimetres in front of the anus, and two divergent lateral incisions about three centimetres long (Fig. 586). After dividing the skin and subcutaneous tissue the perineal septum is reached, which is divided in layers, and in doing this the edge



FIG. 587.—Exposure of the prostate and seminal vesicles.

of the knife should be directed anteriorly in order not to wound the thin anterior wall of the rectum, which here has its perineal curve. Having passed the layer of the external sphincter, the deeper structures are separated by blunt dissection. The bulb of the urethra with its attached Cowper's glands is pushed forward and the anterior wall of the rectum backward toward the sacrum, whereupon the fibres of the levator ani arising from the pubic bones (adductor prostatae) become tense, and between these the posterior wall of the prostate is visible (Fig. 586). If one wishes to expose the latter more completely, the above-mentioned fibres of the levator ani may be divided on both sides, which involves considerable hæmorrhage from the large venous anastomosis between the hæmorrhoidal and prostatic plexus. The posterior wall of the prostate now lies completely exposed. The transverse perineal artery and nerve which pass along the free border of the triangular ligament lie outside the region of the wound. These are the relations when the anatomy of the region is undisturbed, but the operation is much more difficult when these normal relations are destroyed by pathological changes.

The prostate and seminal vesicles can also be exposed by the incision shown in Fig. 587.

For a description of the extirpation of the entire prostate and bladder for carcinoma as performed by Küster, see § 216, page 331.

§ 249. **Injuries and Diseases of Cowper's Glands.**—Cowper's glands lie just behind the bulb on each side of the membranous portion of the urethra, six to eight millimetres from the median line and between the layers of the compressor urethrae muscle (Fig. 586). They are lobulated, acinous glands from four to nine millimetres in diameter. The excretory ducts of the two glands, which vary from three to six centimetres in length, converge anteriorly and pass through the bulb and the urethral mucous membrane, where their orifices lie side by side or one in front of the other and somewhat anterior to the point of entrance of the urethra into the corpus spongiosum. The orifices can only rarely be found in the urethra, but they are sometimes represented by a small fossa or a fold of mucous membrane. From a physiological standpoint it is still a question whether Cowper's glands belong to the generative organs or to the urinary apparatus; Henle thinks that they form a part of the latter. Their secretion, which is discharged both during and after urination, assists in keeping the urethra smooth.

Injuries of Cowper's glands have no clinical importance.

Inflammation of Cowper's glands (Cowperitis) is usually secondary to urethritis—gonorrhœal, for example—and may then be combined with inflammation of the prostate. In other cases it is metastatic in origin, occurring in the course of typhoid, endocarditis, pyæmia, and measles (S. Rona). The enlarged glands can be felt most easily by grasping the region of the bulb between the thumb and forefinger, the latter being introduced into the rectum and the former placed upon the perinaum. If an abscess forms, the pus is discharged either through the urethra or, in case an incision is made, through the perinaum. After the rupture of such abscesses into the urethra, blind pouches are often formed in which a catheter may be caught (Englisch).

In consequence of chronic inflammations, the glands may become permanently enlarged and indurated. Increased secretion of the glands can, like prostatorrhœa, be mistaken for spermatorrhœa.

Tuberculosis of Cowper's Glands takes the form of a tubercular periurethritis, with swelling and formation of fungous tissue in the region of the glands. Tubercular periurethritis starts in the majority of cases from Cowper's glands and can easily be mistaken for carcinoma. The treatment is local, and consists in dividing the fistulae, scraping out the diseased tissue, etc.

Tumours of Cowper's Glands.—Closure of the excretory ducts gives rise to retention cysts, which have been described in detail by Englisch. The closure is usually congenital and results from the coalescence of the opposed epithelial surfaces of the excretory duct. Large retention cysts bulge into the urethra and toward the perinaum, and can be most easily felt in the way described above with one finger in the rectum and the other against the perinaum. The diagnosis can also be made by urethroscopy. The treatment of large retention cysts consists in incision or excision through the perinaum. In the case of cysts which lie within the urethra, puncture of the same with the aid of the urethroscope is possible.

Among malignant tumours of Cowper's glands, Kaufmann mentions three cases of carcinoma. The characteristic location of the tumour at the site of the glands is of importance in making the diagnosis. Malignant tumours are extirpated through an incision along the raphé of the perinæum.

APPENDIX.

Functional Disturbances of the Male Sexual Organs and Neuroses: Impotence.—Sterility in the male.—Aspermia, spermatorrhœa, and other anomalies in the emission of semen.

FOR want of space we shall be obliged to content ourselves here with a very short treatment of this subject, and for a more exhaustive account the reader is referred to Curschmann's article in Ziemssen's *Handbuch*, Bd. ix, pp. 527–562.

§ 250. **Impotence** (*Impotentia coeundi*).—By impotence is understood a diminution or complete absence of the power of performing coitus in a normal manner. If we disregard real deformities of the sexual organs, the main cause lies in the incompleteness or absence of the erection of the penis. Intact testicles are, as a rule, essential to normal erections, and, although they may take place after double castration for a time, yet the ability to produce them gradually disappears completely. Erections are caused by an increase in the amount of arterial blood that flows into the penis and a diminution in the amount of venous outflow, so that an increased amount of blood collects in the meshes of the corpora cavernosa.

The causes of impotence are very numerous. Young married men, for example, with normal generative organs sometimes have a form of impotence known as psychical impotence—i. e., the psychical excitement prevents a normal erection of the penis, probably in consequence of the inhibitory influences of the brain upon the erection centre in the spinal cord (see *Anatomy and Physiology of the Spinal Cord*, § 138). Impotence is frequently due to an irritable weakness, overfatigue, etc., as in masturbators (atonic impotence). Among other causes of impotence there may be mentioned congenital malformations or acquired pathological changes in the genitals, double castration, and interference with erections by cicatrices and thickenings in the corpus cavernosum, in consequence of which the penis becomes so bent on itself as to render its immission impossible. Finally, we should mention the impotence due to paralysis, to diminished excitability, or reflex inhibition occurring in acute and chronic diseases of various sorts, particularly those of the stomach and kidneys, and after the prolonged use of certain drugs, such as arsenic (Charcot), camphor, narcotics (opium, tobacco, etc.).

The treatment of impotence varies with its cause. Any deformity or pathological condition is to be remedied so far as possible. A careful examination should be made in every case of the genitals and the whole constitution of the patient. The prognosis of psychical impotence is usually favourable, and it is only necessary to give the patient encouragement and

overcome the neurasthenia by a general hygienic treatment. It is sometimes a good plan to forbid sexual intercourse for a time. Masturbators should be warned of the harmfulness of their habit. In case of diminished excitability, electricity sometimes works well. Of internal remedies, nuxvomica (Curling), cantharides, and phosphorus have been recommended.

Sterility in the Male is either caused by absence of seminal fluid or the latter may be present, but its composition is abnormal. Sterility in the male is fairly common, although at one time the wife was almost always considered to blame. According to Kehrer, sterility in the husband is the cause of about a third of all childless marriages.

The following main forms of sterility are distinguished :

1. **Azoospermia** means the absence of spermatozoa in the seminal fluid that is ejaculated. This is due either to the fact that no spermatozoa are formed in the testes in consequence of disease of the same, or because the semen does not pass through the vas deferens into the seminal vesicles and then into the urethra. Azoöspermia results, for example, from disease of the epididymis, testicle, and particularly gonorrhœal inflammation of the vas deferens, from inflammatory obliteration of the latter following gonorrhœa or syphilis, from atrophy of the testicle, double cryptorchismus, etc. Azoöspermia is sometimes only temporary. The prognosis and treatment depend in the main upon the cause.

2. **Aspermia**.—In this condition the sexual act is performed normally, but no seminal fluid is ejaculated. Here also there is a temporary and a permanent form to be distinguished. The causes of permanent aspermatism depend mainly upon obstructions to the passage of the spermatic fluid into the urethra. Of these obstructions the most important are strictures of the urethra and congenital or, more frequently, acquired obliteration of the ejaculatory ducts due to gonorrhœa, the presence of concretions, hypertrophy of the prostate, etc. Temporary aspermatism may be caused by inflammatory changes in the region of the ejaculatory ducts and the anterior urethra, and by diminished excitability of the sensory nerve-endings in the glans penis due to masturbation, and of the ejaculation centre in the spinal cord. Aspermatism may also be due to psychic excitement. The prognosis and treatment depend here also mainly upon its cause.

3. **Prospermia, or Prospermatism**, means a premature ejaculation of semen before a complete erection has taken place, and bradyspermia too late an ejaculation after the penis has become flaccid. By hæmospermia is meant the ejaculation of pure blood or blood mixed with spermatic fluid in consequence of hæmorrhage into the seminal passages due to congestion of the seminal vesicles, or from vicarious hæmorrhage in case of hæmorrhoids.

4. **Spermatorrhœa**.—By spermatorrhœa is meant a spontaneous emission of semen in consequence, for example, of some abnormality of the central nervous system or of the sexual organs themselves. It may in the main be regarded as a neurosis. The pollutions which so frequently occur among young individuals at night are physiological at certain periods, particularly among those who abstain more or less from sexual intercourse. Spermatorrhœa is increased in masturbators in consequence of an increased excitability of the parts to voluptuous thoughts. In the more marked degrees of spermatorrhœa spontaneous emissions of semen take place in the daytime, as

well as during urination, defecation, etc. An increased secretion of the prostate (prostatorrhœa), or Cowper's glands, is sometimes mistaken for spermatorrhœa, and a microscopic examination of the fluid should therefore be made. Real spermatorrhœa is caused mainly by a pathological excitability of the central nervous system and the peripheral nerves. Many cases are reflex in nature, and are due to the irritation of a chronic catarrhal inflammation of the prostatic urethra and the verumontanum, or a subacute inflammation of the seminal vesicles following gonorrhœa, etc. Spontaneous emission of semen is, generally speaking, rare, and, at all events, not so common as stated by Lallemand. The prognosis even of the worst cases of spermatorrhœa is favourable, if one understands how to influence the patient psychically and can cure the neurasthenia that is often present.

The patient should avoid all excitement. One should determine in each case whether the spermatorrhœa is a pure neurosis or whether it is caused by pathological changes in the genito-urinary organs. If the former is the case, the treatment is directed against the coexisting neurasthenia, and in case of the latter, against the inflammatory changes in the prostatic urethra, for example. Winternitz recommends as a means of diminishing the excitability of the genital organs the introduction into the urethra of a psychrophore—i. e., a closed catheter through which cold water is allowed to flow. The introduction of large metallic sounds acts in the same way. Electricity also seems to be of distinct benefit. The copper pole of a galvanic battery is placed against the spine, and the zinc pole upon the penis, perinæum, and spermatic cord.

CHAPTER XXVII.

SURGERY OF THE FEMALE GENITO-URINARY ORGANS.

Examination of the female genito-urinary organs.—General remarks on the performance of gynæcological operations.

The Most Important Surgical Diseases of and Operations on the Female Urethra and Bladder: Catheterization.—Deformities of the urethra.—Injuries, inflammations, strictures and dilatation of the urethra.—New growths.—Injuries and diseases of the female bladder.—Calculi.—Foreign bodies.—Tumours of the bladder.

The Most Important Surgical Diseases of and Operations on the External Genitals (Vulva): Deformities.—Atresia vulvæ.—Imperforate hymen.—Excision of the hymen.—Atresia ani vaginalis.—Acquired stenosis of the vulva.—Inflammations.—New growths.—Operations for laceration of the perinæum (perinæorrhaphy, perinæoplasty).

Operations on the Vagina: Congenital and acquired stenosis and occlusion of the vagina.—Operations for prolapse.—Vesico-vaginal fistulæ and other fistulous formations.—Fæcal fistulæ of the vagina.—Tumours of the vagina.

Tumours of the Uterus: Myomotomy.—Supravaginal amputation of the uterus.—Supravaginal excision of the cervix uteri.—Amputation of the cervix.—Vaginal, abdominal, and perineal hysterectomy.

Tumours of the Broad Ligaments, Tubes, and Ovaries: Ovariectomy.—Castration.

§ 251. THE surgery of the female genito-urinary organs can be treated here only very briefly; for a more complete account the reader is referred to the text-books on gynæcology. The surgery of the kidney, ureter, and in part of the bladder, has already been taken up in other chapters.

Examination of the Female Genito-urinary Organs.—In making a thorough examination of the female genital organs a suitable position of the patient is essential in order that the external genitals may be as accessible as possible. Examination in a standing position is seldom sufficient, but the patient should either lie on her back, side, or in the lithotomy or knee-chest position.

The external examination of the abdomen in the case of abdominal tumours consists in inspection, palpation, percussion, and, when necessary, auscultation. The abdominal wall should be as lax as possible, the intestines empty, and in some cases an anæsthetic given. Examination under an anæsthetic is of great importance in the diagnosis of abdominal tumours and diseases of the female generative organs in general, and absolutely essential in many obscure cases.

Examination of the female genital organs consists in external inspection and in vaginal exploration. The index finger which has been besmeared with carbolized oil or vaseline is introduced into the vagina and the different parts are palpated in turn—viz., the orifice, walls, and fornices of the vagina, the cervix, the uterus (its position and size), the surroundings of the uterus, etc. The condition of the urethra, the bladder, and the rectum should also be determined.

The bimanual and rectal methods of examination are very important aids in the diagnosis of pelvic conditions, particularly retro-uterine tumours. In bimanual examination the organ in question is brought between the inside and outside hand and carefully palpated. The index finger of one hand, or, if the vagina is sufficiently large, the middle finger as well, is introduced into the vagina and the other hand palpates the

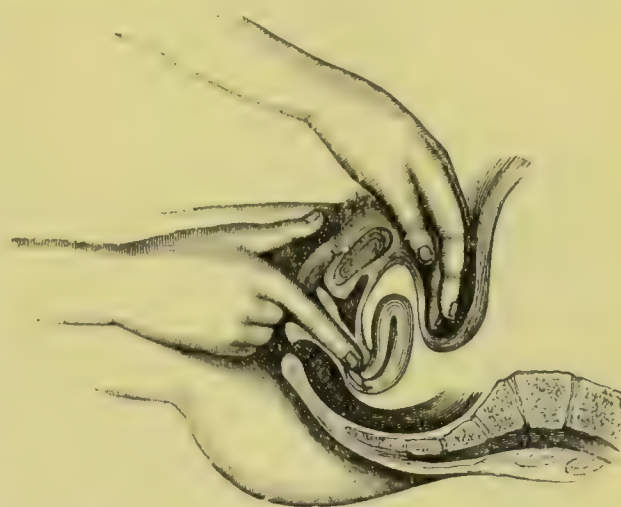


FIG. 588.—Bimanual examination of the female generative organs.

abdominal wall and presses it in as far as possible (Fig. 588). Both hands should be directed toward each other so that only a certain organ or circumscribed area is brought between the external and internal fingers. In this way one can palpate the entire contents of the true pelvis and obtain, especially with an anæsthetic, very important data.

Besides bimanual examination *per vaginam* bimanual examination *per rectum* may be employed, particularly if a vaginal examination is for any reason difficult or impossible or there is a diseased condition in the vicinity of the rectum or between the uterus and the latter. A combined vaginal and rectal examination is often necessary—i. e., the index finger is introduced into the rectum and the thumb of the same hand into the vagina, whereupon one palpates the cervix, posterior wall of the vagina, and the anterior wall of the rectum (Schroeder, Hegar). It is often a very good plan to draw down the cervix with volsellum forceps so that the finger in the rectum can palpate the posterior wall of the uterus.

For a description of rectal examination with the entire hand as recommended by Simon and Nussbaum see § 170, page 134.

The bladder can likewise be examined bimanually through the vagina or rectum. If the urethra is dilated by means of a Simon urethral speculum (Fig. 589), one can easily introduce



FIG. 589.—Simon's urethral speculum.

the finger and instruments into the bladder, palpate the latter, and remove a foreign body, calculus, etc. The external meatus is incised slightly on either side or below with a small pair of scissors, and the smallest size of a Simon speculum is introduced, well oiled and with light rotating movements. The urethra is then dilated to the desired size by introducing specula of gradually increasing diameter. The incontinence that results at first soon disappears completely.

For a description of catheterization of the female, see page 442.

Inspection of the external genitals consists in noting the condition of the labia, the clitoris, the frenum, the urethral orifice, and the hymen.

Inspection of the vagina and cervix is made possible by the use of vaginal specula, of which there are a large number; they are either tubular or consist, like rectal specula, of two, three, or more blades.

The latter variety of speculum is introduced in a closed condition into the vagina, and then opened by a special contrivance. The tubular specula are made of wood, metal, hard rubber, glass, or porcelain, and are circular at both ends, or the smaller end is cut off obliquely (Fig. 590); the latter are used mainly in Germany. The tubular speculum, the diameter of which should always correspond to the size of the vagina, is smeared with vaseline or carbolized oil, and then gently introduced, by means of rotating movements, along the less sensitive posterior vaginal wall until the cervix appears in the opening of the speculum.

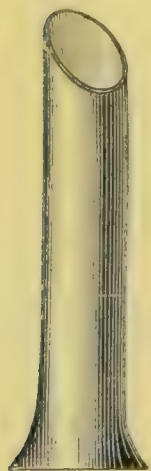


FIG. 590.—Tubular vaginal speculum.



FIG. 591.—Sims's speculum.

The grooved specula with handle, of which that of Sims (Fig. 591) and Simon (Fig. 592) are most used, give the best access to the fornices and cervix and suffice for all cases, particularly operative procedures. The grooved pieces of different length and width belonging to Simon's speculum are intended for the posterior vaginal wall (Fig. 592, *a*), and a num-

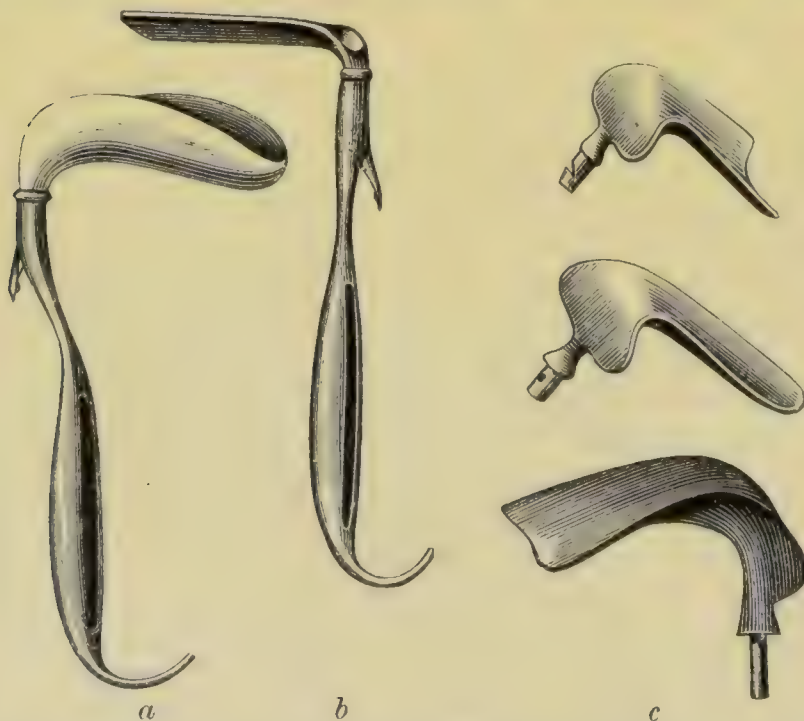


FIG. 592.—A Simon speculum with different attachments: *a*, for the posterior vaginal wall; *b*, for the anterior vaginal wall; *c*, differently curved pieces for the posterior vaginal wall.



FIG. 593.—Simon's vaginal retractor.

ber of flat pieces for the anterior wall (Fig. 592, *b*). It is also a good plan to have a number of curved short and wide flat pieces for the posterior wall as well (Fig. 592, *c*), which can be fitted into the handle of a Simon speculum.

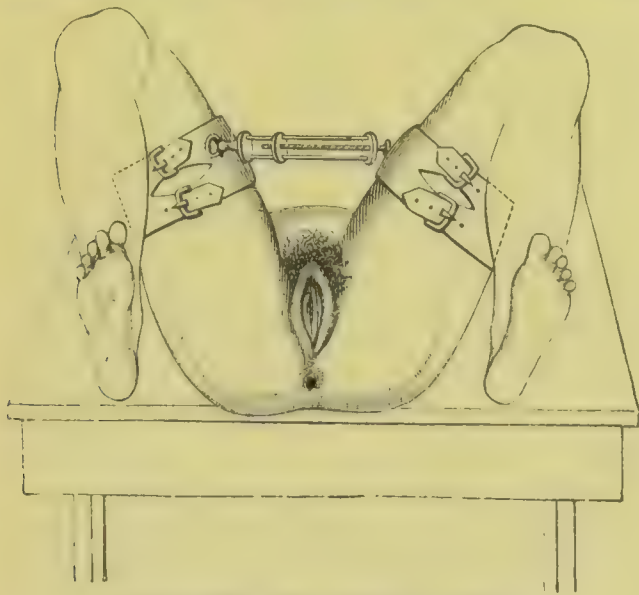


FIG. 594.—Säger's leg-holder.

For exposure of the lateral fornix the best instruments are the lateral retractors of Simon (Fig. 593), Hegar, or Benckiser.

The self-retaining specula should also be mentioned. Nitot, for example, devised a speculum with blades that worked automatically and independently, and a tubular handle which made it possible to examine and treat the internal genital organs both in the dorsal and in the knee-chest position.

For a description of examination of the uterine cavity with a uterine sound and dilatation of the cervix (by laminaria or dilators) for diagnostic and therapeutic purposes the reader is referred to the text-books of gynæcology.

All the above methods of examination should be conducted under the observance of antiseptic precautions.

§ 252. **General Remarks upon the Performance of Gynæcological Operations.**—In order to give the patient a suitable position, a large number of examining and operating tables, leg-holders, etc., have been invented. Operations on the external genitals are performed with the patient in the lithotomy position—i. e., she lies upon her back, and the legs are held by some form of holder or crutch. Säger's crutch (Fig. 594) is adapted from that of Clover (Fig. 544, page 324). The lateral or Sims position is often used in England and the United States, and is particularly adapted for operations in the lateral fornices. For fistula operations the knee-chest position is very serviceable (Fig. 595).

In laparotomies the dorsal position is, of course, used as in all abdominal operations, and elevation of the pelvis is often essential (Trendelenburg position). Some gynæcologists, including Péan, Hegar, Zweifel, and Martin, sit between the thighs of the patient when performing laparotomy. For this purpose low operating tables with an adjustable support for the legs are

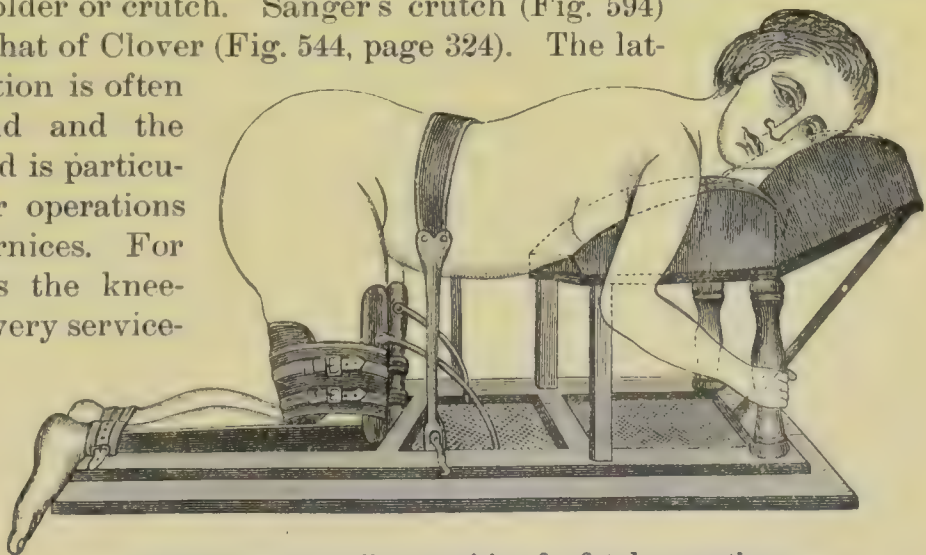


FIG. 595.—Knee-elbow position for fistula operations.

necessary, or the patient's thighs lie upon those of the operator and the legs and feet hang down. Martin's operating table, made of iron and having an adjustable leaf, is the simplest and most useful one for such laparotomies.

As regards the other preparations for a gynecological operation the same rules hold here as for surgical operations in general (see Principles of Surgery). In preparing the patient it is particularly important that the bladder and rectum should be empty. The pubes should be shaved and the vagina thoroughly disinfected by means of douches. The aseptic preparation of the field of operation is particularly important in the case of gynecological operations, because there are an immense number of microbes about the external genitals, in the vagina, etc. The patient should therefore be given a full bath, the entire vicinity of the external genitals rubbed with soap, shaved, and scrubbed with 1-to-1,000 bichloride, the vagina irrigated with the same solution, and, when necessary, packed with aseptic gauze. In operations on the cervix, the latter is brought into view by means of a speculum and disinfected with cotton fastened to the end of a pair of forceps and dipped into an antiseptic solution. In operations on the uterus itself the uterine cavity may be disinfected by the cautious intra-uterine injection of iodoform-glycerin. Any ulcerating or sloughing areas on the cervix are previously removed with a sharp spoon, the thermo-cautery, and thoroughly disinfected with chloride of zinc (1 to 8), bichloride (1 to 1,000), etc. For the other rules of antisepsis and asepsis see Principles of Surgery. In gynecology also, and particularly in laparotomies, antisepsis has given place more and more to asepsis.

Operations on the female generative organs are occasionally followed by mental disturbances, particularly melancholia, and less frequently mania. In such cases there has sometimes been a latent psychosis before the operation.

§ 253. **Surgical Diseases of and Operations on the Female Urethra and Bladder.**—On account of lack of space we shall be obliged to limit ourselves to a very brief description of this subject, and for a more exhaustive account the reader is referred particularly to Winckel's work, entitled *Die Krankheiten der weiblichen Harnröhre und Harnblase*.

Catheterization of the Female Bladder.—Catheterization of the female is performed with straight metallic, glass, or rubber catheters which are slightly curved at one end. In displacement of the bladder the use of a male catheter is often advantageous. The instruments used should, of course, be aseptic, and one must be careful that micro-organisms do not gain entrance to the bladder from the vulva and vagina and cause cystitis. For this reason the vulva and the vicinity of the external meatus should be previously disinfected and the catheter then introduced, pushed straight backward, and finally the outer end lowered somewhat. In prolapse of the uterus the outer end of the catheter should, as a rule, be somewhat raised instead of lowered. In case of other curves and deviations of the urethra the direction given the catheter will have to be changed correspondingly. If the introduction

of the catheter meets with any obstacle, the tip of the instrument within the urethra should be controlled by a finger in the vagina.

In case the surgeon desires to catheterize a patient beneath the bed-clothes without exposing the external meatus, he feels with the left index finger for the somewhat prominent and hard urethral orifice which lies between the clitoris and the protruding fold of the anterior vaginal wall just above the introitus vaginae, and places the tip of the finger on the upper wall of the vaginal orifice just beneath the urethra. The catheter is then passed along the palm of the left hand and the index finger, carried over the vaginal fold and introduced into the urethral orifice. For a description of catheterization of the ureters, see § 201, page 267.

Dilatation of the urethra by means of Simon's specula is described on page 439.

Deformities of the Female Urethra.—Epispadias and hypospadias are very rare in the female. In hypospadias, or congenital absence of the lower wall of the urethra, the sphincter is usually present, so that closure of the bladder is not interfered with. Incontinence is likely to occur, however, late in life. In some cases, particularly when there is incontinence, hypospadias should be operated upon in a similar way as in the male (see page 339), or the opening in the bladder made smaller. Torsion of the urethra as practised by Pousson and Gersuny has also been successful (see page 444).

In epispadias of the female urethra the latter is transformed in part or along its whole length into a grooved canal, and in its severest forms is combined with exstrophy of the bladder (see page 334). The operative treatment of this condition is essentially the same as in the male. In epispadias or fissure-formation that involves only the anterior portion of the vulva but is associated with incontinence, broad oval, freshened surfaces may be made which are united by sutures passed through the labia majora and minora and the clitoris.

Injuries of the urethra are closed in the usual way by suture as well as fistulae, which should be previously freshened (see page 454, Operations for Fistulae).

Inflammations of the female urethra, such as gonorrhœa, cause much less disturbance than in the male. As regards the local treatment, in which a nitrate-of-silver stick can be easily employed, see Treatment of Gonorrhœa, page 354.

Suburethral abscesses sometimes develop which should be opened through the anterior vaginal wall.

Strictures of the female urethra but seldom require special treatment. If it should be necessary, one may employ bougies, laminaria, or internal or external urethrotomy. Strictures of the external meatus are treated by incision with scissors either laterally or directly downward, and the enlarged opening is kept dilated by means of metallic

catheters. For a description of Simon's method of dilating the urethra for purposes of diagnosis and treatment see page 439.

Dilatation of the Urethra; Prolapse.—Dilatation of the urethra is not uncommon and may occur in consequence of immissio penis during coitus when there is a congenital or acquired closure of the vagina. Treatment of this dilatation may be necessary if there is incontinence of urine owing to imperfect closure of the bladder. The urethra can be sufficiently narrowed in such cases by excising an oval piece from the anterior vaginal wall and suturing the wound thus made. Winckel excises a cuneiform piece from the urethro-vaginal septum, with its base toward the vagina and its apex toward the urethra, and closes the wound with sutures. Pawlik recommended the excision of cuneiform pieces on either side of the urethra. In severe cases Schroeder's method may be employed, which consists in separating the upper wall of the urethra from the lower by a horizontal incision on both sides. Anteriorly the denudation is continued further in an upward direction, and the lower flap or lower wall of the urethra is sutured higher up. Pousson and Gersuny obtained good results in incontinence by twisting and flexing the dilated urethra. They made a circular incision about the external orifice of the urethra, incised the vestibulum as far as the clitoris, drew out the urethra, twisted it on its longitudinal axis, and sutured it beneath the clitoris; finally the edges of the vestibulum were united over it. Irreducible prolapse of the mucous membrane of the urethra is treated by excising it circularly and suturing the urethral mucous membrane to the external mucous membrane.

Tumours of the Female Urethra.—Caruncles or polypous excrescences about the external urethral orifice are the most common tumours of the urethra, and are particularly likely to follow injuries in the course of gonorrhœa and other inflammatory processes; they sometimes develop from the glands of the urethra. Neuberger found gonococci in caruncles occurring in gonorrhœa, and hence removal of the caruncles is necessary in order to cure the gonorrhœa. They are removed under local anæsthesia with cocaine by seizing them with forceps, tying them off with silk, and cutting them away with scissors. They may also be excised or burned out with the thermo-cautery. Polyps that are found farther back in the interior of the urethra are removed by dividing the urethra on both sides and afterward suturing it together again, or by dilating it with a Simon urethral speculum.

Malignant tumours of the female urethra (sarcoma, carcinoma) are very rare. They should be removed as promptly as possible by excision of the diseased mucous membrane by means of a circular or

semilunar incision, and the remainder of the urethral mucous membrane sutured to the external mucous membrane. After extirpation of the entire urethra as far as the fundus of the bladder, an artificial urethra may be formed above the symphysis in the linea alba by Zweifel's method. He opens the peritoneal cavity, punctures the posterior wall of the bladder with a pointed scalpel, inserts a soft-rubber catheter, sutures this obliquely along the posterior bladder wall, as in Witzel's method of gastrostomy, and finally unites the peritonæum and omentum over the bladder wall for purposes of protection. In a similar case I made an artificial urethra extraperitoneally in the anterior wall of the bladder, and with the best success.

Injuries and Diseases of the Female Bladder.—For a description of injuries and diseases of the bladder see §§ 207 and 208 (Injuries and Diseases of the Male Bladder). It need only be mentioned here that in severe chronic cystitis, with unbearable tenesmus and sensitiveness of the mucous membrane, an artificial vesico-vaginal fistula may be made, in order to permit complete evacuation of the urine and healing of the inflammation. This procedure may also be necessary in case of injuries and fistulæ.

Sänger had the misfortune while removing an ovarian cyst to mistake the adherent bladder for the pedicle of the cyst, and tied it off and cut through it in three places. He secured the remaining portion of the bladder in the lower angle of the abdominal wound by means of sutures passed transversely through the parietal peritonæum and the stump of the bladder. He then sutured the parietal peritonæum behind the stump of bladder and inserted a glass drainage-tube behind the fold of peritonæum. The abdominal-wound was then closed except at the drainage opening.

Vesical Calculi in the Female.—The diagnosis of vesical calculi in the female is made in the same way as in the male (see § 212, pages 275 and 279). A stone can often be felt by introducing a catheter into the bladder and palpating the latter from the vagina, or by making a bimanual examination.

As regards the removal of a stone, litholapaxy is very easy to perform in the female (see § 213, page 313). After dilating the urethra by means of a urethral speculum (see page 439) stones of considerable size may be removed, either with or without a lithotrite. Large vesical calculi which can not be broken up inside the bladder should be removed by suprapubic cystotomy, just as in the male (see § 214, page 319). The incisions through the vestibule and through the vagina (colpocystotomy) are no longer in vogue. The latter operation is justifiable only in case of a coexisting vesico-vaginal fistula or a vaginal cystocele. In such cases one should divide the fistula or the cystocele

directly upon the stone or foreign body, and after extraction of the same close the wound by exact suture of its edges.

Other foreign bodies are removed in essentially the same way as calculi. Here also the remarkable dilatability of the urethra is a great aid in the extraction of foreign bodies.

For a description of the operation for vesico-vaginal fistula, see pages 454–457 (Operations on the Vagina).

Tumours of the Bladder.—Tumours of the bladder may be exposed (1) by dilatation of the urethra with a urethral speculum; (2) by division of the urethra as far as the neck of the bladder; (3) by colpocystotomy; and (4) by suprapubic cystotomy. Polypous growths can easily be removed by dilating the urethra. If the tumour is attached to the bladder wall by a broad base or is malignant in character, suprapubic cystotomy or colpocystotomy should be performed. In the latter operation the fundus of the bladder is opened from the vagina, dividing, if necessary, the urethra, the tumour drawn into the wound and separated from its attachments, or a corresponding piece of the bladder wall resected. After arresting the hæmorrhage by ligation, irrigation with ice-water, etc., the wound in the bladder is either sutured at once or subsequently. If one chooses not to close the wound in the bladder until later, a soft-rubber catheter may be introduced and the bladder packed with iodoform gauze.

For a description of tubercular cystitis, see Surgery of the Male Bladder, page 297.

§ 254. Diseases of and Operations on the Vulva.

Malformations of the Vulva.—Congenital atresia, or closure of the vulva, is very rare, while acquired, complete, or partial atresia, due to pathological processes, is more common. In congenital atresia there is either an epithelial agglutination of the opposed surfaces of the labia majora and minora in consequence of deficient cornification of the superficial layers of epithelium, or there is a firm adhesion of these surfaces. In the former case the agglutination can be remedied by a probe, and in the latter case division with a knife is necessary. Reunion of the edges is prevented by the insertion of iodoform gauze, or, in case the knife is used, by a continuous catgut suture. This condition is usually noticed by the mother soon after the birth of the child, owing, perhaps, to interference with urination.

Imperforate Hymen.—The orifice of the vagina is sometimes closed by a dense membrane in place of the hymen. This condition is usually not recognised until the age of puberty, at which time serious disturbances may result in consequence of interference with the escape of the menstrual blood. The latter accumulates in the vagina, the uterus, and the tubes (hæmato-colpos, hæmatometra, hæmatosalpinx), and may give rise to very large collections of blood. In some cases the closure is only a partial one, the membrane not being adherent along its upper border.

The treatment of imperforate hymen consists in division or excision

of the membrane in question, and its reunion is prevented by continuous catgut suture of the edges of the mucous membrane. The operation is not without danger when a large amount of menstrual blood is present in the vagina, uterus, and tubes, because infection of the same may give rise to peritonitis. Hofmeier thinks that such patients should not be anaesthetized, as vomiting may cause rupture of the tubes that are distended with blood, which if decomposed may give rise to peritonitis. He recommends making a small incision under cocaine in the bulging membrane and then allowing the blood to flow out without further manipulation. About a week later an anaesthetic may be given, the membrane divided or excised, and the edges of the mucous membrane united with catgut sutures on each side.

Excision of the Hymen is indicated in case the latter is too thick, so that coitus is impossible or very painful. In such cases marked vaginismus is often present—i. e., abnormal irritability of the external genitals with spasmodic contraction of the sphincter vaginae and all the muscles of the floor of the pelvis. The treatment consists in division or excision of the thick hymen, and the edges of the mucous membrane are united by a continuous catgut suture.

Atresia Ani Vaginalis.—In this condition there is a post-foetal persistence of the cloaca; the rectum communicates with the vagina, or both rectum and vagina have a common external opening and are not separated from one another by the perinaeum. For a more exact description see § 171, page 136. (Imperforate Anus). In atresia ani vaginalis the skin of the anal region is divided, the end of the rectum found and dissected free, and then sutured to the external skin. The defect in the vagina is closed at once by suture. Instead of this, the end of the rectum may be opened, the line of incision in the latter sutured to the external skin, and the recto-vaginal fistula closed at a later operation. In cases where there is a special anal opening besides the abnormal opening into the vagina, a plastic operation may be employed (see Perinaeoplasty, § 255, page 449).

Acquired Stenosis of the Vulva.—Stenoses of the vulva are the result mainly of inflammatory adhesions following injuries, burns, etc. They should be divided by an incision which is forked below; a skin-flap of the proper size is then sutured into the posterior angle of the wound.

Inflammations of the Vulva are very numerous and belong more to the subject of gynæcology. The most frequent are those caused by gonorrhœa, intertrigo, and chancre. Ulcerations occur mainly in chancre and gonorrhœal vulvitis. Non-specific ulcers are sometimes found on the genitals of prostitutes, which result from the continual re-opening of cicatrices due to the repeated irritation. Vulvo-vaginitis is common among young girls in asylums, and is communicated by means of bed linen, underclothes, hands of the attendants, sponges, bathing-water, etc. In some cases the inflammation is true gonorrhœa. Vulvo-vaginitis is treated according to general principles by astringent douches, the application of compresses wet with ice-water or aqua plumbi, and the insertion of tampons of iodoform gauze which have been smeared with unguentum diachylon, oxide of zinc, alum ointment, and the like.

Superficial erosions and ulcerations are healed most quickly by cauterization with the nitrate-of-silver stick. For the treatment of chancreoid ulcers, see Treatment of Chancre in the Male (§ 228, page 379). Inflammation of the Bartholinian glands is not uncommon, and often goes on to the formation of an abscess. These glands lie at the posterior border of the triangular ligament, and are covered by the bulbo-cavernous muscle. The excretory duct opens on either side in front of the lateral point of origin of the hymen. Abscesses are opened by a free longitudinal incision.

Tumours of the Vulva.—New growths occur upon all portions of the vulva. Warts or vegetations are the most common, and are caused mainly by catarrhal inflammation of the vulva. As the result of syphilis, broad condylomata develop in this region, and in its later stages gummata.



FIG. 596.—Elephantiasis of the clitoris.



FIG. 597.—Elephantiasis of the clitoris.

Tuberculosis of the vulva is very rare. The labia are frequently the seat of a lipoma, fibroma, or carcinoma. Cysts are common and are either retention cysts of the mucous glands or the Bartholinian glands. A cyst may develop within an empty, closed hernial sac just as in an empty hernial sac in the male.

Enormous tumours sometimes result from elephantiasis of the labia and the clitoris, which is very frequent in the tropics (Figs. 596 and 597, after W. Busch).

Tumours of the vulva are treated on general principles, and should be excised in such a way that the edges of the wound can be united by suture. Pedunculated tumours may be tied off with silk thread, and then removed with scissors or a scalpel. In removal of the clitoris (clitoridectomy) the same is drawn forward with volsellum forceps and cut away, together with the neighbouring portions of the labia minora, and the resulting hæmorrhage is arrested by suture of

the wound. In suitable cases the new growths may be removed with the galvano-cautery or thermo-cautery.

For a description of labial hernia see Hernia (page 210).

§ 255. **Surgery of the Perinæum.**—Lacerations of the perinæum occur frequently during delivery, much less often from other traumatisms. We distinguish complete and incomplete lacerations. In the latter there is a rupture of the posterior commissure of the vulva and rhaps of the perinæum, while in complete lacerations the tear extends into the rectum, so that the latter gaps and the vulva, vaginal orifice, and anus form one common opening.

The small incomplete lacerations are usually sutured immediately after termination of labor, while suture of fresh complete lacerations is, for different reasons, difficult. On this account complete lacerations usually come under treatment when already cicatrized. The disturbances due to these complete ruptures of the perinæum are very great, as such women have incontinence of both fæces and flatus.

Treatment of Lacerations of the Perinæum.—In fresh lacerations the edges of the tear should be united at once under antiseptic precautions, with or without an anæsthetic, depending upon the extent of the laceration. A continuous suture is preferable, because it can be applied very quickly. Deep lacerations should first be diminished in size by means of a continuous buried catgut suture, and over this a second continuous catgut suture is inserted, which is made more secure by a few interrupted tension sutures of silk.

Numerous methods of operating have been devised for the different degrees of old lacerations, which will be found described more in detail in the text-books of gynæcology, particularly those of Hegar-Kaltenbach, Schroeder, Martin, Hofmeier, and Zweifel. Two main varieties of operation may be distinguished—viz.: (1) simple (usually triangular) denudation of the cicatrized laceration followed by suture (Dieffenbach, Simon, Hegar-Kaltenbach, Freund, Martin), and (2) the flap methods of Wilms, Langenbeck, Voss, Fritsch, Lawson Tait, and Staude. In the latter method a vaginal flap is dissected up from the rectum, so that none of the tissue is sacrificed, as in the former methods. As Küstner rightly states, the same method should not be employed for every case, but that one should be chosen which is best adapted to the case in hand.

Previous to every operation for old laceration the patient should be prepared by catharsis, fluid diet for two days before, sitz baths, and several vaginal and rectal douches, one of which should be given while the patient is under an anæsthetic on the table. The evening before the operation twenty drops of tincture of opium should be ad-

ministered, and the field of operation shaved, scrubbed with soap and water, and rubbed with ether and 1-to-1,000 bichloride. During the operation, which is usually performed with the patient under an anæsthetic, but by some surgeons with cocaine, the field of operation is irrigated with sterilized water in case of complete laceration, and with bichloride (1 : 5,000–10,000) in in-



FIG. 598.—Perinæorrhaphy: *a*, buried catgut suture.



FIG. 599.—Perinæorrhaphy: Martin's method of denudation.

complete lacerations. The main things in every perinæorrhaphy are strict asepsis and careful suture.

The triangular method of denudation was first employed by Diefenbach and Simon, and was afterward modified by Hegar, Freund, and Martin. The methods of denudation shown in Figs. 598 and 599 are very serviceable. If the laceration is a complete one, extending into the rectum, the denudation is continued into the rectum. A tampon with a string attached is introduced into the latter. The best plan is to make first the lower curved incision, and then the other incisions, care being taken to keep the area to be denuded on the stretch by means of tenacula. The area of mucous membrane which has been marked out is dissected up from below by means of a pointed double-bladed scalpel, held as flat as possible. The wound surface is then smoothed off with curved scissors, and after all hæmorrhage has been stopped by torsion and ligation with catgut, the wound is sutured in such a way that its edges are in broad coaptation without any tension. For suture materials, silk, catgut, silkworm gut, and silver wire are used. Complete lacerations used to be repaired by suturing first the rectum, then the vagina, and lastly the perinæum, so that the wound, after triangular denudation, had finally the appearance shown in Fig. 600. Superficial and deep sutures alternate, and the formation

of empty spaces is to be guarded against. It is a better plan to suture the tear in the rectum through the perineal wound by means of buried catgut sutures. Schroeder's method of closing the wound by means of two layers of a continuous catgut suture is a very excellent one. He first diminishes the size of the wound by a continuous buried catgut suture from the vagina to the commencement of the tear in the rectum (Fig. 598, *a*), and then closes the wound in the rectum by a continuous suture which does not include the mucous membrane. A second continuous suture is then inserted from the anus to the upper angle of the denuded surface within the vagina. These continuous buried sutures may be strengthened by the insertion of single interrupted sutures. The wound is now completely closed by interrupted sutures of catgut, silk, silkworm gut, or silver wire, beginning first in the vagina and finishing in the perinæum.

Among the flap methods which have come more and more into use of late years, those of Fritsch, Simpson, and Lawson Tait deserve especial mention; they are adapted both for incomplete and complete lacerations. Fritsch, who devised the same method independently of Simpson and Tait, detaches the rectum from the vagina along two incisions which run into one another; the vagina then retracts upward while the rectum is drawn downward with a loop of silk. In complete laceration the rectum is closed by buried catgut sutures, which do not include the mucous membrane. The vaginal wound is next united, and finally the perineal wound by interrupted sutures, which should include as much tissue as possible.

The method used by Tait is as follows: He first separates in the same way the vagina from the rectum by splitting the recto-vaginal septum with the scissors. A vaginal flap is then marked out by making lateral incisions to the point where the labia minora merge into the labia majora, so that finally the wound surface of the perinæum is **U**-shaped. The transverse incision is from 3·5 to 4 centimetres long and the two lateral incisions from 2·5 to 3 centimetres. In complete laceration the incisions should be made in such a way that a **U**-figure results with short posterior limbs. The vaginal flap is detached anteriorly and the posterior flap posteriorly. All the sutures (silver wire) are inserted through the perineal wound. This form of perinæoplasty is suitable both for lacerations of the perinæum and for abnor-

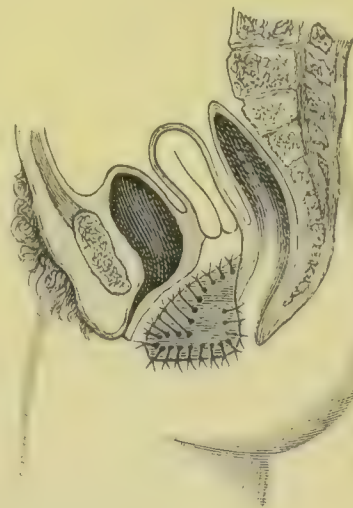


FIG. 600.—Perinæorrhaphy: The newly formed perinæum after triangular denudation.

mal size of the vaginal outlet and as a final operation for all degrees of prolapse of the vagina.

The flap methods just described are advantageous on account of their great simplicity, and are to be preferred to the method first described because none of the mucous membrane is cut away. Hegar, Küster, and others have found fault with Tait's method because it unites tissue which physiologically does not belong together.

§ 256. **Operations on the Vagina.**—Strictures and atresiae of the vagina are both congenital and acquired. In atresia there is either a transverse band in an otherwise normal vagina, or the latter is largely wanting. Congenital atresia is usually not noticed until the age of puberty, and makes itself known at that time by absence of the menstrual flow and by accumulation of menstrual blood in the ovary, uterus, and vagina (*hæmatosalpinx*, *hæmatometra*, and *hæmatocolpos*). The treatment is mainly the same as that of analogous conditions of the vulva. Here also the blood that has collected should be cautiously evacuated and the wound prevented from closing by packing the vagina in case a continuous catgut suture of the edges of the mucous membrane is impracticable. In suitable cases one may infold a flap of the external skin into the vagina and suture it in place (*Credé*). Simon collected seventy cases of atresia of the vagina, of which fifty were cured and twenty died; this seems a surprisingly high mortality. Stenosis of the vagina can sometimes be cured simply by blunt dilatation with the finger. Septa are divided with scissors or the knife, whereby injury to the bladder and rectum must be carefully avoided.

Prolapse of the Uterus and Vagina.—Prolapse of the female generative organs is usually a result of relaxation of the floor of the pelvis. The following varieties are distinguished: 1. Prolapse of the lower part of the anterior vaginal wall. 2. Prolapse of the upper third of the anterior vaginal wall, complicated in rare cases by prolapse of intestine between the uterus and bladder. 3. Prolapse of the upper part of the posterior vaginal wall, which is somewhat more frequent than that of the anterior wall. 4. Prolapse of the lower half or two thirds of the posterior vaginal wall outside the vulva; the vaginal prolapse often contains a protrusion of the anterior rectal wall (*rectocele*). The above-mentioned forms of vaginal prolapse have numerous combinations with one another. 5. Prolapse of the uterus with or without coexisting prolapse of the vagina. The uterus usually undergoes pathological changes, particularly hypertrophy and elongation of the cervix. The different forms of prolapse are usually found in combination with one another. Prolapse of the anterior vaginal wall with *cystocele* and prolapse of the uterus with elongation of the cervix are the most

common varieties. Prolapses are sometimes so marked that the uterus, together with the anterior and posterior vaginal walls, lie completely outside the vulva.

Treatment of Prolapse of the Vagina and Uterus.—For a suitable prophylactic treatment, including the use of pessaries, etc., the reader is referred to text-books on gynaecology; the radical operative treatment will alone be described here. Operative treatment is preferable to all other forms, such as the use of supporting apparatus, and should be employed in case a too-advanced age or any disease of the patient renders a cure doubtful.

Literature contains a large number of different operations for prolapse. Prolapses of the anterior and posterior vaginal wall are treated by anterior and posterior colporrhaphy, and prolapse of the uterus by suitable operations, particularly amputation of the cervix. In prolapse both of the uterus and vagina with hypertrophy of the cervix, amputation of the cervix should first be performed, and then anterior and posterior colporrhaphy. All these operations may be performed at one sitting. Anæsthesia should always be used, as cocaine is unsatisfactory. The preparation of the patient is the same as for perinæorrhaphy (see page 449).

Operation in two stages as employed by Fehling is preferable. After amputation or cuneiform excision of the cervix he performed a double anterior colporrhaphy by dissecting up two oval vaginal flaps whose axes converge somewhat toward the cervix and inserting buried and superficial sutures. The latter are removed on the tenth to the twelfth day. Finally colpo-perinæorrhaphy is performed. Severe cases of prolapse of the uterus are sometimes treated by ventral fixation (see page 469) or by vaginal hysterectomy. Freund opened Douglas's space from the posterior fornix, sutured the uterus on the right and left side, and packed the vagina with thymol gauze. Vaginal hysterectomy is indicated in large prolapses with adhesions of the uterus, or when the latter has lost all support and lies almost completely outside the vagina, or, finally, in tumours of the prolapsed uterus, particularly carcinoma. Of the different operations for prolapse we shall first describe anterior and posterior colporrhaphy. Amputation of the cervix and vaginal hysterectomy are described in § 257.

Anterior and Posterior Colporrhaphy.—Specula are inserted and the uterus is drawn down with volsellum forceps, or, in case the cervix has just been amputated, with sutures that are left long for the purpose. The anterior vaginal wall is then made tense on each side and above with tenacula and denuded in the way shown in Fig. 601. The defect is diminished in size by means of a continuous buried catgut suture,

and then closed by a second continuous catgut suture; the latter may be strengthened by a few interrupted sutures of silk.

Posterior colporrhaphy is performed by denuding the posterior vaginal wall as shown in Fig. 602 or Fig. 599 (page 450), and inserting, as in anterior colporrhaphy, two rows of continuous catgut sutures. The perineal wound is closed by interrupted sutures of silk or silver wire (Fig. 602, *b*). Of late, Tait's perinæorrhaphy is frequently employed as a final operation in all degrees of prolapse of the vagina.



FIG. 601.—Anterior colporrhaphy: *a*, buried catgut suture.

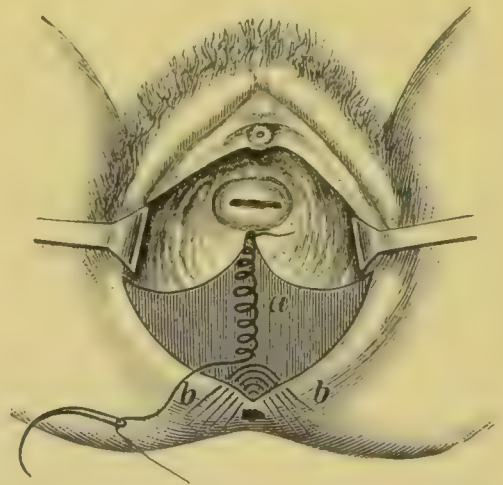


FIG. 602.—Posterior colporrhaphy: *a*, buried catgut suture; *b*, interrupted sutures at the lower part of the perinæum.

In inoperable prolapses of the entire uterus, hysterectomy is indicated, particularly if the uterus is diseased.

For a description of ventral and vaginal fixation of the prolapsed uterus see page 469.

Operations for Urinary and Fæcal Fistulæ of the Vagina.—Urinary fistulæ result usually from traumatism, particularly during delivery or from operations, less frequently from diseases of the vagina, uterus, bladder, and urethra. The following varieties are distinguished: Urethro-vaginal fistulæ, vesico-vaginal fistulæ, uretero-vaginal fistulæ, vesico-uterine or vesico-cervical fistulæ, with their different transition forms, and finally, as the rarest form, uretero-uterine fistulæ. The most frequent forms are the vesico-vaginal and vesico-utero-vaginal fistulæ. Small fistulæ frequently heal spontaneously or after cauterization; if this is not the case, operative measures are to be adopted. We shall be able to give here only a very brief description of the operations for fistula; more detailed accounts will be found in the works of Simon, Winckel, and Hegar.

Preliminary treatment of the patient is not necessary in mild cases. Frequently, however, it will be necessary to make the fistula or field

of operation more accessible and movable by means of hot vaginal douches and by gradual dilatation of the cicatricial walls of the vagina with spherical or cylindrical hard-rubber dilators (Fig. 603) or by division of dense cicatricial bands. Hofmeier recommends packing the vagina with iodoform gauze for a considerable time. Such preparatory measures may require several weeks, but without them a successful operation is often impossible. Forceful dilatation of the vagina by rupture and division of the cicatricial bands takes a shorter time, but it seems to me questionable whether this is as good a procedure. The sooner after its development a urinary fistula is operated upon the better. Hegar, for example, performs the operation from six to eight weeks after confinement. In other respects the preparation of the patient is similar to that for perinæorrhaphy (see page 449).

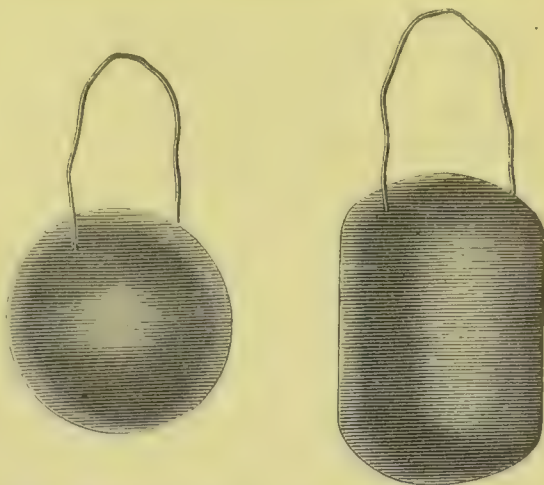


FIG. 603.—Spherical and cylindrical hard-rubber dilators for vesico-vaginal fistulæ (Bozeman).

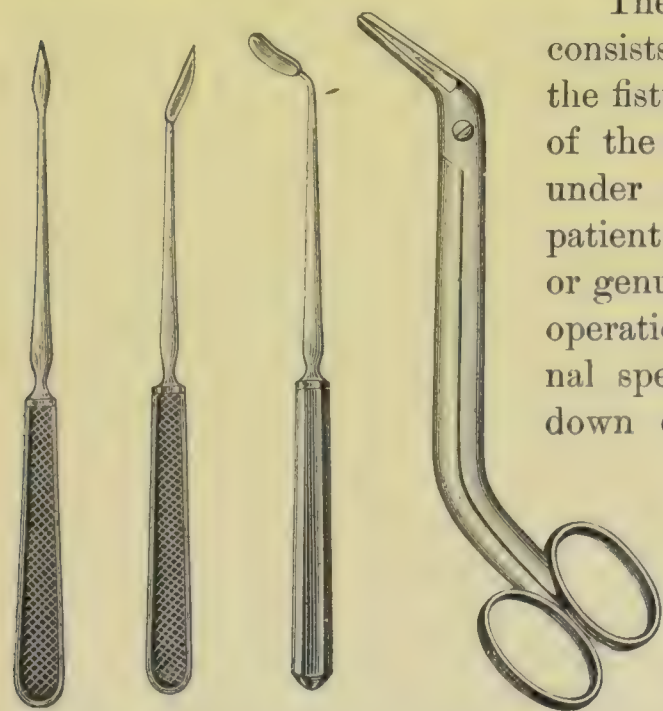


FIG. 604.—Knife and scissors for the denudation of vesico-vaginal fistulæ (Bozeman).

The operation for urinary fistula consists of three steps: 1. Exposure of the fistula. 2. Denudation. 3. Suture of the same. The operation is done under ether or with cocaine, and the patient is placed in the lithotomy, Sims, or genu-pectoral position. The field of operation is exposed by means of vaginal specula, and the uterus is drawn down either by means of a loop of thread passed through the cervix, by a tenaculum, or by volsellum forceps. The tissue about the fistula should also be made tense by means of tenacula, and its edges inverted toward the vagina by means of a catheter in the bladder.

The edges of the fistula should then be carefully freshened on all sides with a scalpel or some special instrument (Fig. 604) which is made to cut in an oblique direction. The scissors shown in Fig. 604 are intended mainly for smoothing the freshened edges of the fistula.

All cicatricial tissue in the vicinity of the fistula should be removed, in order that the edges of the wound may consist of normal tissue.

The freshened edges of the fistula are now approximated by interrupted sutures inserted with a curved needle and a needle holder. The sutures should be introduced in such a way as not to cause any tension. The best suture material is silver wire, but other surgeons prefer silk, silkworm gut, or catgut. All the sutures should be inserted before any are tied. If there is much tension, and particularly in the case of large fistulæ, tension sutures should be inserted at some distance from the edges of the wound. The chief thing is to obtain exact coaptation of the edges.

The after-treatment consists in packing the vagina with iodoform gauze, rest in bed until the eighth to the tenth day, if necessary in the lateral position, and in light diet. The sutures are usually removed on the fourth to the sixth day, but sometimes a few are left in longer. A catheter is used to draw off the urine only when absolutely necessary.

Vesico-uterine fistulæ often require exposure by division of the cervix. They are then excised by a funnel-shaped incision and sutured in a longitudinal direction. In case the fistula is situated high up and hard to find, it may be cured by denudation and suture of the external os or the lower part of the cervix (hysteroceleisis, Jobert). A great disadvantage of this method is that the menstrual blood is discharged through the fistula into the bladder.

Vesico-utero-vaginal fistulæ at the place of reflection of the cervix on to the vaginal fornix are closed by freshening and suturing the anterior wall of the cervix and the opposed vaginal mucous membrane in a transverse direction. In large defects of the anterior lip of the cervix the anterior and posterior lips should be freshened and united longitudinally to the previously denuded mucous membrane of the vagina (Hegar), or the posterior lip may be sutured to the lower edge of the fistula, so that the cervix communicates with the bladder.

All vesico-vaginal fistulæ which can not be healed by operating within the vagina should be closed within the bladder after performing suprapubic cystotomy. The patient is given the Trendelenburg position. Fistulæ or large defects may also be closed by means of a pedunculated flap taken from the posterior vaginal wall (Trendelenburg). After the flap has healed into the defect, which requires a few weeks, its pedicle is divided and the fistula or defect closed on all sides. The urine is temporarily evacuated by suprapubic drainage. In suitable cases of vesico-vaginal fistula the bladder may be detached from the vagina as completely as possible and each sutured separately (Herczel).

In case of large defects of the urethra an attempt may be made to form a new urethra by cutting a flap from the neighbouring mucous membrane or from the external genitals (Fritsch). Small defects may be closed by denudation and suture of the upper and lower portion of the urethra. In case of complete extirpation of the urethra an artificial urethra may be made above the symphysis. If it is impossible to close a fistula or restore a gap in the urethra, one may as a last resort close the vagina below the fistula (colpocleisis, Simon). In doing this, the vagina is first freshened just below the fistula by removing a circular piece of tissue about a centimetre and a half in width, and the wound united transversely, so that the vagina is completely obliterated at this point. The patient's condition is improved by this operation only when the urine can be held by the sphincter. Vesical calculi have in some cases developed after colpocleisis, and in others the opening had to be restored at the request of the woman and her husband for the sake of permitting coitus. If the sphincteric action of the bladder is wanting in the case of defects of the urethra, Rose has proposed closing the vagina and urethra and allowing the urine and menstrual blood to pass through a recto-vesical fistula into the rectum; the sphincter ani is thus made to assume the function of the sphincter vesicæ. The results of this operation have been in part satisfactory and in part so unsuccessful that the vagina and urethra had to be reopened in consequence of the accumulation of decomposed fæces in the vagina. In order to prevent the entrance of fæces into the vagina and bladder, Rydygier cut a triangular flap from the posterior vaginal wall, united its mucous membrane with that of the rectum, and pushed it into the rectum to act as a sort of valve. The communication between the rectum and vagina or bladder was closed down to a small fistula for the escape of urine into the rectum. The formation of an artificial urethra above the symphysis would probably be better in such a case (see page 445).

The most difficult fistulæ to operate upon are the uretero-vaginal and uretero-uterine, in which a direct closure is impossible. Simon proposed connecting the ureter with the bladder indirectly by making an artificial vesico-vaginal fistula and then closing the vagina below. Schede, in one case of uretero-vaginal fistula, made at first a large vesico-vaginal fistula, into which he subsequently healed the ureter. Bandl cured two cases of uretero-vaginal fistula by the following method: He made an artificial vesico-vaginal fistula as near the other fistula as possible, and through this he introduced a ureteral catheter which passed through the urethra and bladder into the distal open end of the ureter. Over the catheter he united the vaginal mucous mem-

brane, which was first freshened in the form of two longitudinal oval wound surfaces. No method has yet been found of healing uretero-uterine fistulæ by direct means. When possible, the fistula should be exposed within the uterus by dilatation of the latter, the cervix removed, an artificial vesico-vaginal fistula made in the neighbourhood of the fistula, a catheter introduced into both fistulæ, and the vaginal mucous membrane sutured over it. Hahn cured one case by making a vesico-vaginal fistula and closing the vagina below. In several cases ureteral fistulæ have been cured by removal of the kidney on that side (Simon, Credé, Zweifel, and others), or grafting the proximal end of the ureter into the bladder, large intestine, or rectum.

In case of imperfect closure of the bladder following fistula operations cold vaginal douches are given, a Schatz pessary inserted, or an elliptical strip of vaginal mucous membrane excised and the wound sutured (Winckel). Pawlik gave the urethra a sharp bend about the symphysis and stretched it transversely by means of a plastic operation in order to overcome incontinence. Torsion of the urethra as practised by Pousson and Gersuny is very useful (page 444). In suitable cases the urethra may be closed and a permanent fistula made above the symphysis. If the incontinence is the result of defective dilatability of the bladder, this may be overcome by means of irrigation, the amount of fluid used being gradually increased.

Fæcal Fistulæ of the Vagina (Recto-vaginal and Entero-vaginal) are not common, and result partly from traumatisms and partly from inflammatory processes.

The entero-vaginal fistulæ involving the small intestine are either narrow openings or there is an artificial vaginal anus through which the entire intestinal contents are discharged into the vagina. It is not rare for such fistulæ to heal of themselves. In the milder cases an attempt should be made to cure the fistula by denudation and suture. If there is an artificial vaginal anus with a spur, the latter should be removed by Dupuytren's or Collin's enterotome (see Fig. 458, page 132), and the fistula closed by a plastic operation. Casamayor proposed establishing a communication between the end of the small intestine and the rectum, and then closing the vagina below this fistula. In some cases an intestinal fistula can only be cured by laparotomy (resection and suture of the intestine).

In the case of large recto-vaginal fistulæ situated low down the perinæum may be divided below the fistula, and then the complete laceration of the perinæum thus made can be closed in the usual way. In mild cases the fistula should be denuded, if possible, through the vagina and closed by suture, or through the rectum, after dividing the sphincter posteriorly (Simon, Emmet). It is a very good plan to split the vagina for a distance of one centimetre above and below the fistula, separate the vagina from the rectum, and then close the fistula by invaginating its borders toward the interior of the rectum and inserting rows of sutures. In the worst cases, par-

ticularly when the fistula is situated high up, it may be necessary to extirpate the rectum by the method of Kraske or Bardenheuer.

Vaginal fistulae sometimes result from persistence of Gartner's canal, and occur in the vicinity of the vesico-vaginal septum; they discharge a clear albuminous fluid. The fistulous tract is retroperitoneal, and passes along the uterus to the region of the kidney. Milton, Lawson Tait, and others have described such cases. Milton successfully united the vaginal end of the canal with the bladder. Lawson Tait did not succeed in curing his case by extirpation of the broad ligament.

Tumours of the Vagina.—Tumours of the vagina are not common; they include fibrous polypi, papillomata, cysts, fibromata, sarcomata, and carcinomata. Primary sarcomata are sometimes congenital, and are particularly common in children. Out of twenty-five cases of primary sarcoma collected by Gatti, seventeen occurred in children and seven in adults, while in one case it was congenital.

Pedunculated tumours are removed with scissors after tying off their pedicle. In case they have a broad insertion, some of the surrounding normal tissue must be excised at the same time. The prognosis of the rare primary sarcomata is unfavourable, and the patient usually succumbs to recurrences or metastases; a permanent cure is very rare.

Vaginal cysts have a varied origin; they develop most frequently from the mucous glands, or they have some connection with the Wolfian or Müllerian ducts. The cysts may be enucleated *in toto* after dividing the overlying mucous membrane, and the wound either sutured or packed with gauze. It is simpler, particularly in the case of large cysts, to cut away the cyst at its base, so that its posterior wall remains behind. The latter is sutured all around to the edges of the vaginal mucous membrane; this stops the hæmorrhage, and the remains of the cyst finally come to resemble the mucous membrane more and more. Interstitial fibromata and fibro-myomata of the vagina are removed by enucleation.

Carcinomata of the vagina should be removed, as long as they are movable on the deeper parts, by cutting around them superficially through healthy tissue. The wound is sutured or allowed to heal by granulation. If the carcinoma is in the vicinity of the cervix it will be necessary to remove a part or the whole of the latter. Deeply seated, immovable carcinomata of the vagina which have involved the bladder and rectum are usually no longer suitable for operation, because, as a rule, the lymph glands and pelvic connective tissue are already diseased, making operative measures hopeless.

For a description of Dührssen's vaginal cœliotomy see page 47.

§ 257. **Operations on the Uterus.**—Among operative procedures on the uterus we shall take up mainly those that are performed for

tumours of the uterus, particularly myomotomy, supravaginal amputation of the uterus, amputation or excision of the cervix, and vaginal, perineal, and abdominal hysterectomy. The other diseases of and operations on the uterus belong to the domain of gynæcology. The above enumerated operations for tumours of the uterus can only be treated here very briefly, and for a more detailed description the reader is referred to the text-books on gynæcology.

Tumours of the Uterus.—Among tumours of the uterus we shall first take up myomata and fibromata. Myomata are made up, as a rule, of unstriped muscular fibres, with a very variable supply of connective tissue, blood-vessels, and lymphatics; in most cases we have to do with mixed tumours, particularly fibro-myomata. Myomata are either confined to a certain part of the uterus or are more diffuse, having developed from numerous small centres, and may form enormous tumours. The majority of myomata are interstitial—i. e., they develop within the uterine wall and grow from here toward the inner or outer surface of the uterus, where they form submucous or subserous tumours which are either pedunculated or sessile. Fibromata of the cervix are much rarer than those of the uterus itself. It is of great practical importance that fibroid tumors frequently diminish gradually in size after the menopause, just like the wall of the uterus, and they may disappear altogether. Calcification and fatty degeneration are not infrequent. In other cases they undergo myxomatous or cystic degeneration (myxo-fibroma, myxo-myoma, cysto-fibroma, cysto-myoma). Dilatation of the blood-vessels and lymphatics may give rise to telangiectatic, cavernous, and lymphangiectatic myomata and fibromata. The cystic myomata and fibromata are to be regarded in the main as cavernous lymphangiomas. Fibro-myomata sometimes suppurate and become gangrenous, or they may change into sarcomata or carcinomata. The most frequent outcome of fibroid tumours is, however, cessation of growth and shrinkage, or they break through the mucous membrane of the uterine cavity and become pedunculated polyps. These submucous tumours or polyps may be discharged through the vagina.

The symptoms of fibroid tumours depend largely upon their location and further development. Tumours that remain interstitial may be present for a long time without causing any symptoms. Later on hæmorrhages are likely to occur which may become serious, and, moreover, symptoms due to the growth of the tumour, with pressure on the neighbouring organs. Submucous tumours and polyps that lie in the uterine cavity frequently give rise to pain similar to labour pain. As the tumour increases in size it can usually be easily recognized, par-

ticularly on bimanual examination. In not a few cases, however, fibroids of the uterus have been mistaken for pregnancy.

Treatment of Myomata and Fibromata of the Uterus.—In the first place, attempts have been made to check the growth of the tumour and diminish its size. For this purpose the use of mineral waters that contain iodine (Tölz, Kreuznach, Salzbrunn), the administration of iodide of potassium and arsenic, dieting, and, above all, injections of ergotin, have been recommended. After each injection the patient should lie quietly for half an hour. Hæmorrhage is arrested by styptics, the thermo-cautery, and sometimes by dividing the mucous membrane over the submucous myoma. Double castration has also been frequently performed, and diminution in the size of the tumour attained in this way. In place of castration, all the main uterine vessels, or only the uterine artery, have been tied either intra-peritoneally or extra-peritoneally (see page 470). Electrolysis has of late been taken up again, and gradual diminution in the size of the tumour brought about.

If conservative treatment is unsuccessful, or for any reason contra-indicated or dangerous, operative removal of the tumour, either through the vagina or by laparotomy, is then indicated. The pedunculated polyps are best adapted to extirpation through the vagina, as they are accessible in this way, and can be removed with the *écraseur*, the galvano-caustic loop, or by twisting, tearing off, or ligating the pedicle. Large fibrous tumours are best removed by laparotomy followed by myomotomy.

The technique of myomotomy varies with the mode of development of the tumour, and is simplest in the case of pedunculated subserous tumours. After exposing the tumour by an abdominal incision the pedicle is transfixed, tied off in two portions with aseptic silk, and the tumour cut away above the ligatures. It is often a better plan to surround the pedicle or body of the uterus temporarily with a piece of rubber tubing, then divide the pedicle by means of a cuneiform incision, and finally close the latter by deep and superficial sutures. After sponging the peritonæum dry and replacing and disinfecting any coils of intestine that have protruded, the abdominal wound is closed in the way described on page 47.

In non-pedunculated tumours of the body of the uterus where the uterus has itself become a part of the tumour, supravaginal amputation of the uterus is preferable. For the purpose of stopping hæmorrhage the cervix is tied off with a piece of rubber tubing the thickness of the small finger; the broad ligaments are either included in the elastic ligature, or, if they are too tense, they are doubly ligated and divided between the ligatures (Fig. 605). The tumour is then divided

in the median line from above downward nearly to the rubber ligature, the cavity of the uterus is, if exposed, disinfected with a strong bichloride solution, and each half of the tumour is cut away above the ligature after previously tying off the tube and broad ligament on

each side. Removal of the tumour above the ligature is accomplished as follows: A transverse incision is made through the peritonæum about three fingers above the ligature, and

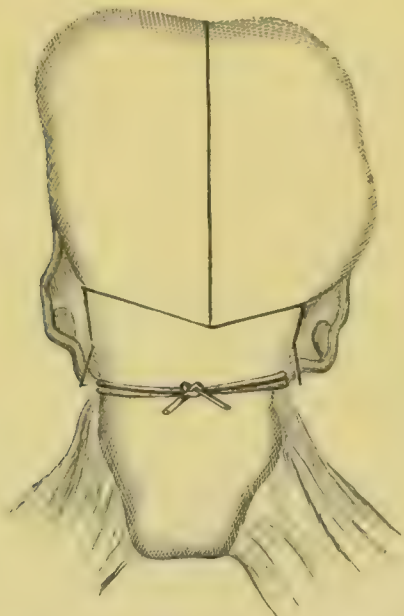


FIG. 605.—Supra-vaginal amputation of the uterus with elastic constriction of the cervix by means of rubber tubing.

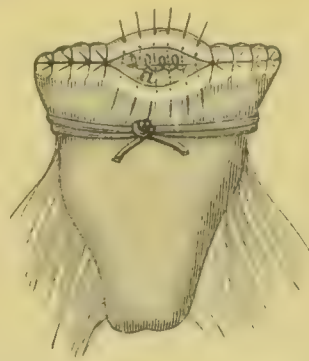


FIG. 606.—Suture of the stump after supra-vaginal amputation of the uterus.

the tumour or body of the uterus is then cut through in the form of a wedge. The uterine cavity or cervical canal are, if opened, thoroughly disinfected with a strong solution of bichloride, excised as completely as possible, and closed by continuous catgut suture. Finally, the edges of the stump of the uterus are united by deep sutures of silk and superficial sutures of catgut after the peritonæum has been previously inverted over the wound surfaces (Fig. 606). The elastic ligature is now loosened, and any hæmorrhage is arrested by additional deep or superficial sutures, and, if necessary, by the application of ligatures *en masse*. The further treatment of the stump of the uterus varies with different surgeons; it either remains intraperitoneal or is sutured into the abdominal wound, so that it becomes extraperitoneal. Some surgeons introduce for the first few days a drainage-tube through Douglas's pouch into the vagina, and the latter is packed with iodoform gauze.

In intramural fibroids of the body of the uterus in which the uterine cavity has not been entered by the tumour but is separated from the latter by a layer of normal tissue of variable thickness, the tumour is shelled out of the wall of the uterus after applying an elastic ligature and incising the serous covering. The defect is then closed by deep sutures after inverting the peritonæum over the wound surface.

Martin performs myomotomy as follows: The vagina is thoroughly douched with bichloride twenty-four hours before operation and packed with bichloride gauze. After opening the abdomen he ligates and cuts through the broad and round ligaments as far down as the cervix. A transverse incision is made into the fold of the peritonæum on the posterior surface of the uterus until the posterior fornix is opened. The forefinger is passed into the latter, and with this as a guide the cervix is cut out from the floor of the pelvis, except in front, where it is attached to the bladder. The bladder is detached by blunt dissection, and the removal of the uterus completed. All catgut ligatures project into the vagina. The peritonæum is united by continuous catgut sutures, so that finally nothing but these sutures remains within the abdominal cavity.

Chrobek has in particular recommended in suitable cases the enucleation of myomata through the vagina. After dilating the cervix with tents and dilators, or making radiating incisions with scissors or the knife, the uterus is drawn down with volsellum forceps, the overlying tissue divided by a transverse or longitudinal incision, and then the tumour removed with the finger, the *écraseur*, the galvano-caustic loop, or, better, with the knife, after applying an elastic ligature. The uterus is finally irrigated with a solution of salicylic acid or thymol and packed.

The extirpation of fibroid tumours that have grown between the layers of the broad ligament and beneath the pelvic peritonæum may be extremely difficult. The best method in such cases is to first tie the ovarian and uterine arteries, incise the peritonæum covering the tumour, and then shell out the latter with the fingers. If there is a pedicle, this should be tied off as well as the Fallopian tube. The bed of the tumour is then drained through Douglas's pouch toward the vagina, or, in case the tumour has been shelled out of the broad ligament, the entire sac is sutured into the lower angle of the abdominal wound and packed with iodoform gauze (Fritsch). Tumours of the pelvic connective tissue and other retro-uterine new growths, abscesses, etc., may, in suitable cases, be made accessible through the perinæum (see Fig. 549, page 330, and Fig. 586, page 432).

Malignant Tumours of the Uterus include sarcoma and carcinoma. The adenoma may likewise be regarded as malignant, since it is prone to change into a carcinoma. The adenoma takes the form either of a diffuse proliferation of the mucous membrane or of a polyp. It should be removed by energetic curettage of the uterine mucous membrane and cauterization of the same with some fluid caustic. If a cure is not obtained in this way, vaginal hysterectomy is indicated, in view of the possibility of its becoming a carcinoma.

Carcinoma of the uterus is very common and is usually localized in the cervix or the body of the uterus. Carcinoma of the cervix takes the form either of a superficial hard epithelioma of the portio

vaginalis, of carcinoma of the cervical mucous membrane, or of carcinomatous nodules in the substance of the cervix. Carcinoma of the mucous membrane of the cervical canal is usually secondary to that of the portio vaginalis (Leopold). The clinical course of a carcinoma of the cervix is characterized by pain, profuse hæmorrhages, a very foul discharge, and progressive ulceration and destruction of tissue. In making the diagnosis the clinical course and the microscopic examination of excised portions of tissue are important.

Every carcinoma of the cervix should be removed as promptly as possible by free excision through healthy tissue. In case of an epithelioma that is confined to the portio vaginalis, high amputation of the cervix is usually sufficient. The surest treatment is removal of the entire uterus. In carcinoma of the mucous membrane of the cervical canal and in carcinomatous nodules within the cervix, hysterectomy is the only radical method of treatment. Unfortunately, however, the majority of carcinomata of the cervix come under treatment too late, when a radical cure is no longer possible. In such cases the most that can be done is to lessen the pain, hæmorrhage, and sloughing by some palliative measures, such as curettage or the application of the thermocautery. If, however, hysterectomy is performed early for carcinoma of the cervix there is a prospect of permanent cure, and this has been attained in a considerable number of cases.

Carcinoma of the body of the uterus is much rarer than that of the cervix. It takes the form, as a rule, of diffuse infiltrations and large, deep ulcerations, with rapid destruction of tissue. The main symptoms are hæmorrhages, increased discharge, pain, enlargement of the uterus, and progressive loss of strength.

The only operations that come into consideration for carcinoma of the body of the uterus are supravaginal amputation of the uterus and vaginal or abdominal hysterectomy. As long as the tumour is confined to the upper part of the uterine cavity, supravaginal amputation may be performed, but it is better in every case to remove the entire uterus. The permanent cures following vaginal hysterectomy for carcinoma are becoming more and more frequent of late. Out of one hundred and fifty-five cases which were followed for five years, 25·7 per cent were found to be free from recurrence (Olshausen). Vaginal hysterectomy for cancer of the uterus should be performed as early in the disease as possible. If the latter operation is impossible owing to the enlargement of the uterus or a small vagina, abdominal hysterectomy should then be performed. In doing this operation the cervix may first be separated from its connections through the vagina, just as in performing a high amputation of the cervix; or supravaginal amputation of

the uterus may first be performed and the cervix then removed through the vagina.

In all cases where a radical operation is no longer possible one should diminish the pain, sloughing, etc., by palliative operations and morphine. Palliative operations consist in energetic curettage with a sharp spoon and in the application of the thermo-cautery and caustics, the latter in the form of chloride of zinc (2-to-3 aqua), or fuming nitric acid may be applied after the eschar made by the cautery has been cast off.

Sarcoma of the uterus developing either in the mucous membrane or in the parenchyma of the uterus is extremely rare. It usually attacks women from thirty to fifty years of age, particularly those that have never borne children (Terrillon). Only two out of the fourteen cases seen by Terrillon had had children. The growth of sarcomata of the uterus is usually very rapid, although the general condition of the patient may remain unaffected for a long time. Important points in the diagnosis are the rapid growth of the tumour or marked increase in the size of the uterus and a continuous bloody discharge. The prognosis is unfavourable, and recurrences are the rule after extirpation. The treatment is the same as for carcinoma. For small tumours vaginal hysterectomy should be performed, and for larger ones abdominal hysterectomy.

Tuberculosis of the mucous membrane of the uterus is either secondary—e. g., to tuberculosis of the tubes—or a primary affection. Small inflammatory nodules are first formed which change into ulcers. In the more advanced cases the entire uterine cavity may be converted into a tubercular ulcer covered with caseous and purulent material. For the diagnosis the detection of tubercle bacilli is conclusive. The treatment consists in energetic local measures (curettage and cauterization of the scraped surfaces with liquor ferri chloridi, etc.).

Amputation of the Cervix.—Amputation of the cervix on a level with the vaginal fornices is insufficient even for the most superficial epitheliomata, and is adapted only to benign tumours and other affections of the portio vaginalis. The best methods are those of Hegar and Schroeder or a combination of both. Hegar's operation is as follows: The uterus having been drawn down so as to make the cervix sufficiently accessible, the lips of the os are divided on each side as far as the lateral fornices, a good-sized conical piece is excised from the posterior lip, and deep interrupted sutures are inserted. The anterior lip is then treated in the same way. In Schroeder's operation the mucous membrane of the cervical canal is likewise excised. He splits the cervix in the same way on each side, and, upon drawing the two lips apart, cuts perpendicularly into the cervix, anteriorly and posteriorly, just above the diseased mucosa. External incisions are then made from below upward, meeting the perpendicular incisions, thus

making a wedge-shaped wound surface on each lip, which is closed by deep sutures.

High or supravaginal amputation of the cervix consists of the following three steps: 1. Temporary ligation of the broad ligaments, or rather the large arteries contained within them (uterine and ovarian). 2. Amputation of the cervix. 3. Suture. After the field of operation has been thoroughly disinfected the cervix is seized and drawn to one side and the broad ligaments tied off temporarily by introducing on each side close to the uterus a fairly large curved needle armed with stout silk. Before tying the ligatures the cervix is brought back again to the median line. The cervix is split up on each side, and at first the posterior lip amputated as high up as possible after dissecting up the posterior fornix; the edge of the posterior fornix is then united to that of the cervical canal by deep sutures. The anterior lip is treated in the same way after dividing the anterior reflection of the vaginal mucous membrane and separating the cervix cautiously from the bladder. The temporary ligatures about the broad ligaments are finally removed and the vagina irrigated and packed with iodoform gauze. In case there are cicatricial adhesions the operation may be very difficult, and not infrequently the peritonæum is wounded and Douglas's pouch opened. The peritonæum should then be sutured with fine catgut, and, if necessary, Douglas's pouch drained.

Vaginal Hysterectomy, which has been reintroduced particularly by Freund, Czerny, Fritsch, and Martin, is indicated in carcinoma and sarcoma of the uterus as described above. It has also been performed for malignant adenoma, incurable prolapse, hæmorrhagic endometritis at the time of the menopause in place of castration, for diseased adnexa, etc. It is contra-indicated in the case of a malignant tumour that has extended beyond the uterus, in case of adhesions with the vicinity, and where the uterus is very large.

In performing the operation the uterus is separated from its attachments from below upward both with the scissors or knife and by blunt dissection, beginning either in the anterior or posterior fornix. The hæmorrhage is arrested by double ligation. Finally the uterus is turned over forward or backward and removed after clamping, tying off and dividing any remaining connections on each side (broad ligaments and tubes). Desguin and other surgeons do not open Douglas's space until the last, in order to prevent, as far as possible, the entrance of infection through this space—from a sloughing carcinoma, for example. Doyer, after opening the anterior fornix, divides the uterus by a sagittal incision into a right and left half, and then inverts and removes each half separately. Of the different methods of perform-

ing vaginal hysterectomy, I shall describe the one employed by Martin.

The patient having been previously prepared by shaving, thorough disinfection of the external genitals and vagina, and evacuation of the intestines, is anæsthetized and placed in the lithotomy position. The vaginal fornices are exposed by means of specula and a vaginal retractor, and the cervix drawn forward and downward with volsellum forceps. The posterior fornix which is thus made tense is incised transversely close to the cervix, detached from the latter, and Douglas's pouch opened so that the tip of the left forefinger can be introduced. The peritonæum is now sutured to the edge of the vagina with a small curved needle and catgut (Fig. 607), which prevents all hæmorrhage. If the wound

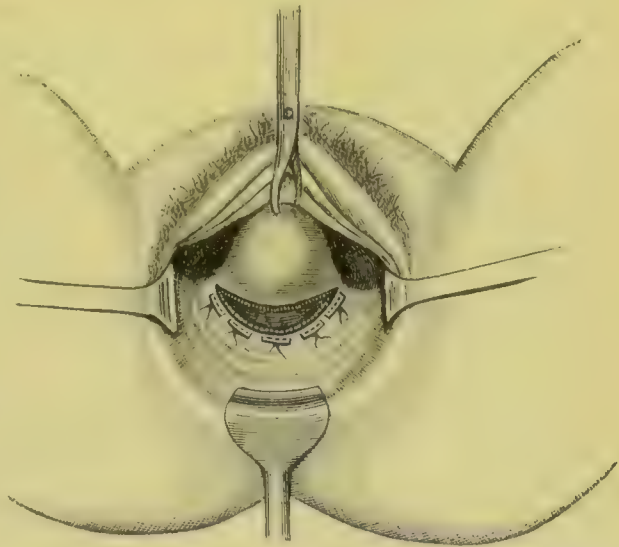


FIG. 607.—Vaginal hysterectomy: Douglas's pouch opened and the posterior vaginal fornix sutured (Martin).

surface of the uterus bleeds considerably, a large needle with catgut may be passed through it, and the ends of the suture left long in order to fix the uterus. A moderately large curved needle armed with stout silk is now thrust through the lateral reflection of the vagina as near the uterus as possible, and after being carried through the base of the broad ligament is brought out again near its point of insertion (Fig. 608). About three such sutures should be inserted on each side and drawn tight so as to shut off the afferent vessels before they are divided.

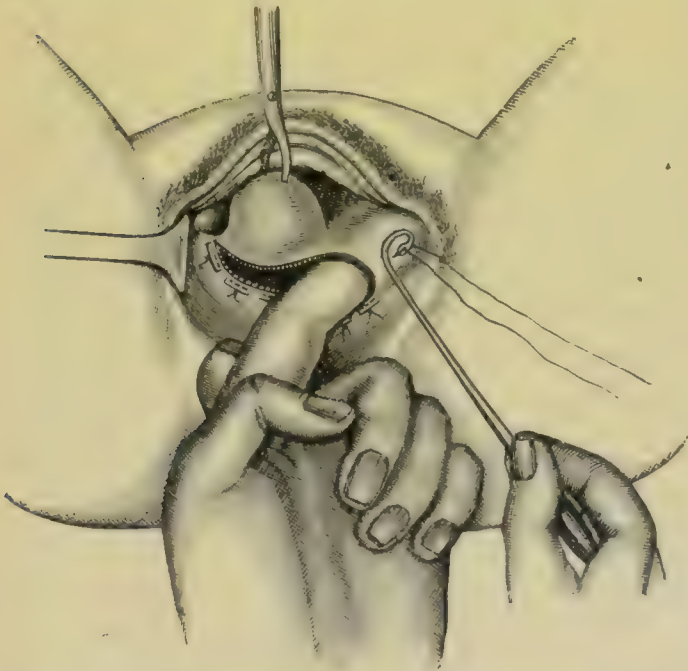


FIG. 608.—Vaginal hysterectomy: Tying off the broad ligament.

The cervix is now separated, usually without hæmorrhage, from its connection with the floor of the pelvis. After any hæmorrhage has

been arrested the uterus is drawn well backward, the anterior fornix incised, and the bladder stripped off bluntly with the fingers. Any firm bands of tissue are divided close to the uterus with scissors or the knife. The anterior edge of the vagina is then sutured in the same way as in the posterior fornix. The posterior lip of the cervix is now drawn well forward by volsellum forceps, a Simon vaginal retractor is introduced into Douglas's space, and the fundus seized with volsellum forceps and brought out posteriorly. If the connections of the uterus with the floor of the pelvis have been divided sufficiently it can be drawn down in this inverted position as far as the vulvar outlet. The unsevered attachments of the broad ligaments, the tubes, and the round ligaments are now tied off and divided close to the uterus. Any coils of intestine that tend to protrude are held back by a large sponge. After arrest of any hæmorrhage by suture or ligation the wound is thoroughly disinfected with 1 to 5,000–10,000 bichloride and packed, as well as the vagina, with iodoform gauze. If there is no fever the gauze packing is not changed until the sixth or seventh day. The patient is given fluid diet at first, and this is continued until all nausea ceases. In order to diminish peristalsis it is a good plan to administer just before the operation fifteen to twenty drops of tincture of opium.

French gynecologists in particular, instead of tying off the adnexa of the uterus, use long clamps which remain in place for from two to four days and are then removed. If the clamps are removed too soon, profuse secondary hæmorrhage may ensue

Abdominal Hysterectomy.—The operation for removal of the uterus through an abdominal incision consists mainly in tying off and dividing all the connections of the uterus, particularly the broad ligaments, tubes, etc. The intestines must be previously emptied. After opening the peritoneal cavity the coils of intestine are pushed aside and protected with warm aseptic compresses, and the uterus is seized and drawn outward with forceps. The broad ligaments and tubes are now doubly ligated and divided without difficulty. The most difficult step is the complete detachment and enucleation of the cervix without hæmorrhage and without injury to adjacent organs. This part of the operation should be done preferably through the vagina before performing laparotomy (see supravaginal amputation of the cervix, page 465). One may also amputate the body of the uterus within the abdomen and then remove the stump through the vagina. After completion of the operation the ligatures lie inside the vagina and the latter is packed with iodoform gauze. I do not consider it a good plan to shut off the peritoneal cavity entirely from the vagina. Abdominal hysterectomy for carcinoma of the uterus has been replaced

in part by vaginal hysterectomy. The mortality of the former is comparatively high.

Hochenegg has recommended the sacral route for extirpation of the uterus, which is similar to Kraske's operation for extirpation of the rectum (page 172) ; Zuckerkandl removes it through the perinæum (see pages 330 and 433). Schede has successfully employed the sacral method of hysterectomy in thirty-five cases ; the field of operation is well exposed, and cases can be operated upon in this way which are no longer suitable for vaginal hysterectomy. Sacral hysterectomy is performed as follows : The patient is placed in the dorsal position with the pelvis well elevated and the thighs sharply flexed upon the abdomen. A longitudinal incision is made in the median line, beginning two to three centimetres from the border of the anus and extending to the lower half of the sacrum ; the coccyx is excised, and, if necessary, a piece of the last sacral vertebra. The greater and lesser sacro-sciatic ligaments are now severed on each side, and one works inward mainly with the finger toward that side of the rectum where the parametrium seems to be most infiltrated. The rectum is retracted to one side with blunt hooks. The posterior vaginal wall is now made to bulge outward by means of a stick sponge, and the vagina is incised transversely over the sponge. The vagina is next separated from the carcinoma and the uterus drawn out into the wound and detached much the same as in vaginal hysterectomy. Hochenegg performed sacral hysterectomy twenty-four times with two deaths. According to Frommel, Zuckerkandl's perineal method, which he performed by first separating the bladder through the vagina, is only of use in removing retro-uterine tumours, exudates, and suppurating hæmatoceles. Säger has likewise removed tumours of the pelvic connective tissue through the perinæum.

Schuchardt has recommended and performed with success perineo-vaginal hysterectomy mainly for complicated cases of carcinoma of the uterus, with fixation of the latter and involvement of the parametrium, where vaginal hysterectomy would be very difficult. The cutaneous incision and lateral longitudinal division of the vagina are made on the side where the broad ligament is diseased. The incision begins between the middle and posterior third of the labium majus, encircles the anus by a slightly convex outward curve, and terminates on a level with the tip of the coccyx. This incision is deepened, particularly at its anterior portion, in the fatty tissue of the ischio-rectal fossa, until the vaginal wall is exposed. The vagina is now divided longitudinally from below upward as far as the cervix. The field of operation is now easily accessible, and the further course of the operation is the same as in vaginal hysterectomy. The operation is easy, can be quickly done, and healing takes place much more rapidly than in the sacral method.

Fixation of the Uterus for Displacements.—In case of an adherent retro-flexed uterus the adhesions may be divided by a thermo-cautery and the then movable uterus held forward by suture or by a pessary, etc. The most important indication for hysteropexy is retroflexion, while the contra-indications are broad, dense adhesions, a very small uterus, and very short rigid sacro-uterine ligaments. The fear of future pregnancy should not be considered a contra-indication, as women operated upon in this way have fre-

quently had normal deliveries. The different methods of fixation of a displaced uterus are as follows, some being intraperitoneal and others extraperitoneal: 1. Tait's intraperitoneal method. He opens the abdominal cavity, inserts two or three metallic or silk sutures through the fundus and abdominal wall, and closes the abdominal wound; in a few days the sutures are removed. 2. This is like the first method, except that in addition the anterior wall of the uterus is scarified (Leopold). 3. The peritoneal cavity is opened and sutures are passed through the free edge of the wound, the peritonæum, and the anterior wall of the uterus. After the sutures have been inserted the abdominal wound is closed (Terrier, Czerny). 4. Ols-hausen's method, in which the horns and sides of the uterus are sutured to the abdominal wall. 5. Fixation of the uterus to the periosteum of the symphysis by means of three sutures passed through the middle and sides of the uterus (Kümmell). 6. Fixation of the tubo-ovarian ligaments (Kelly). 7. Fixation of the broad ligaments (Winiwarter). 8. An incision is made above the symphysis down to the peritonæum, and the uterus, which is held forward by means of a uterine sound, is attached to the abdominal wall by means of sutures passed through the fundus and anterior wall (Caneva, Kaltenbach, and others). 9. Vaginal fixation (Schicking-Thiem). In case of prolapse Freund fixes the uterus by passing three or four circular sutures of silver-wire through the vaginal walls and allowing them to heal in. The first suture encircles the portio vaginalis, passing in and out of the mucous membrane. When this suture is tied the portio vaginalis retracts well upward. Below this suture two or three more silver-wire sutures are inserted from one to two fingers' breadths apart. This operation, which can be done in a few moments, requires no after-treatment. 10. Alexander's operation. This consists in finding the ends of the round ligaments at the external inguinal ring, drawing them forward two to four centimetres, cutting them off, and suturing the stumps to the surrounding tissue. The most effectual of these operations is ventral fixation, which will probably never be replaced by vaginal fixation. For a description of these operations, as well as of massage in female diseases, I shall have to refer the reader to text-books on gynæcology.

Ligation of the Uterine Vessels.—Gubaroff has recommended extraperitoneal ligation of the vessels supplying the uterus (the uterine and ovarian arteries and the artery of the round ligament, with preservation of the anastomoses with the vaginal branches in order to prevent gangrene) for severe hæmorrhages, fibroids, inoperable carcinomata of the uterus, and, finally, as a preliminary step in the removal of many uterine and intraligamentous tumours. He operates as follows: The cutaneous incision is the same as that for tying the common and internal iliac arteries (see § 157, page 32). After dividing the three layers of muscle and the transversalis fascia the peritonæum is detached from the iliac fossa and the point of bifurcation of the common iliac looked for on the inner border of the psoas muscle. If the internal iliac is followed into the true pelvis, one can see the origin of the uterine artery which crosses in front of the ureter. The ovarian artery can also be made visible in the same way. The artery of the round ligament can be tied in the lower angle of the wound either alone or with the round ligament; or the deep epigastric, from which the former arises,

can be tied. Rydygier has recommended the extraperitoneal ligation of all the uterine vessels from within the abdominal cavity for fibroids, and Gottschalk and Kürtner ligation of the uterine alone from the vagina.

§ 258. **Tumours of the Broad Ligaments, Tubes, and Ovaries; Ovariectomy and Castration.**—Among tumours of the broad ligament the cysts are most common, some of which develop from the remains of the Wolffian body and others from the ciliated ducts of the parovarium. Echinococcus cysts of the broad ligament have also been observed. The cysts contain usually a clear, slightly albuminous fluid, and only exceptionally reach a large size. Among solid tumours, myomata and fibro-myomata are most common.

Tumours of the Fallopian tubes are rare. Small fibromata and fibro-myomata, starting in the muscular coat, have been observed as well as sarcomata. Primary carcinomata of the tubes are very rare, and it is much more common for a carcinoma of the uterus to attack the tubes secondarily. The small pedunculated or sessile cystic formations (pedunculated hydatids of Morgagni) have no surgical importance.

Tuberculosis sometimes attacks the tubes, and is either a manifestation of tuberculosis of other organs or appears as a primary lesion (Wenth). Only the latter variety is suitable for operative treatment.

Among tumours of the ovary the cysts are the most common, of which several forms are distinguished. The cysts due to dropsical degeneration of the Graafian follicles are usually small—for example, the size of a fist and but rarely as large as a man's head—always unilocular, and are surrounded by a usually tough capsule. Much more frequent than these cystomata are the large cystic tumours of the ovary, which are made up of innumerable cysts of different sizes. The contents of the small cysts are usually more or less mucous or gelatinous in character, that of the



FIG. 609.—Ovarian cyst.

larger ones is thinner, and that of the very large cysts more serous. The inner surface of the cysts is lined either with pavement or with cylindrical or ciliated epithelium. This multilocular cystoma is an epithelial tumour or adenoma, and hence the name adenocystoma (Klebs, Waldeyer). The first step is a proliferation of the glandular epithelial cells in the form of glandular tubes, which then develop into cysts. As the cysts continue to grow the walls of adjacent cysts frequently

disappear, and in this way cystic spaces of constantly larger dimensions result. If the cysts contain papillary growths, the whole tumour is called a *cysto-adenoma papilliferum*. Ovarian cysts sometimes form large tumours weighing from twenty to forty kilogrammes and more. A cure may be brought about by spontaneous or traumatic rupture of the cyst into the peritoneal cavity or the intestine. Hæmorrhages frequently take place into the sac. Both the simple adeno-cystomata and the papillary cystomata may give rise to metastases in the abdominal cavity, and sometimes contain carcinomatous areas.

Primary carcinomata of the ovary which are solid tumours are much rarer than the above-described cystomata or adenomata. Other solid tumours are fibromata, fibro-sarcomata, and sarcomata, which appear as nodules from the size of a walnut to that of a man's head. Fibromata sometimes contain unstriped muscle fibres. Papillary fibromata and papillary carcinomata have been observed in very rare cases on the surface of the ovary. Fibromata and sarcomata are sometimes found in combination with adenomata and cystomata (adenofibroma, adenosarcoma, cystofibroma, cystosarcoma). Marchand described an *angeiosarcoma* and Leopold a *lymphangeioma cystomatosum*.

Dermoid cysts of the ovary are fairly common, and either occur alone or in combination with adenocystomata; they contain a characteristic pultaceous material with hair, pieces of cartilage and bone, teeth, and, in rarer cases, nerve fibres and gray nervous matter. Dermoid cysts grow very slowly, and are not infrequently complicated by inflammation, suppuration, and perforation into the vagina, rectum, or bladder.

The diagnosis of ovarian tumours is made usually by bimanual examination of the patient—if necessary, under an anæsthetic. By palpating in this way the pelvic organs, one can usually determine approximately the location of the tumour, its consistence, size, and the existence of a pedicle. As regards differential diagnosis, one may have to consider the possibility of tumours of the uterus, the broad ligament and the tubes, parametric and perimetric exudates, urachal cysts, hydronephrosis, echinococcus cysts of the abdominal organs, and, in case of smaller tumours, beginning pregnancy.

The radical treatment of ovarian tumours—particularly ovarian cysts—consists in extirpation of the same by ovariectomy as soon as the tumour is recognised. Evacuation of cysts by puncture, which was at one time frequently resorted to, has been displaced more and more by ovariectomy since the beginning of antiseptic surgery. After puncture the fluid usually collects again and must be evacuated anew. In the same way puncture followed by drainage or by the injection of tincture of iodine for the purpose of obliterating the sac has been rightly

abandoned. Puncture is performed in essentially the same way as described on page 44.

If an ovarian tumour is complicated by pregnancy, ovariectomy is, in my opinion, always indicated, and should be performed preferably before the fifth month. Ovariectomy has been successfully performed even after the commencement of labour.

Ovariectomy.—The operation is performed with the strictest observance of asepsis, and of all the other precautionary measures relating to the preparation of the patient, the temperature of the operating-room, the protection of the patient from cold, etc., are to be carried out in the way already described on page 45 for laparotomy.

After opening the peritoneal cavity by an incision in the linea alba below the umbilicus the larger tumours usually appear at once. The first step is then to introduce the hand into the peritoneal cavity and ascertain whether or not the tumour is adherent. If the latter is not the case and the tumour is of moderate size it can be lifted out of the peritoneal cavity *in toto*. In the case of large solid tumours it is often necessary to enlarge the incision beyond the umbilicus, or add a transverse one. Large cysts should be diminished in size by puncture either with a knife or a trocar to which a piece of rubber tubing is attached for drawing off the fluid into a vessel below. In case the cyst is incised with a knife one should try to prevent the cyst contents from flowing into the peritoneal cavity by pressing the abdominal parietes against the cyst wall, although there is no danger in case the fluid is aseptic. As soon as enough of the fluid has been evacuated the puncture opening is closed with an artery clamp and the tumour is drawn cautiously out of the abdominal cavity with the hand or a Mouzeux volsellum forceps. The pedicle is tied off preferably in several sections with aseptic silk or catgut and then divided above the ligatures upon an aseptic gauze compress or flat sponge placed underneath. The stump of the pedicle should not be divided too close to the ligatures, as they may become loosened. Any visible vessels in the stump are tied separately by way of precaution. If one is assured that the pedicle has been properly cared for and there is no hæmorrhage from it, it should be carefully disinfected with 1-to-1,000 bichloride and replaced in the peritoneal cavity. The extraperitoneal method of treating the pedicle by means of a clamp and fixation in the abdominal wound is seldom employed at present. The other ovary should always be examined, and if diseased should likewise be removed. Any fluid that has escaped into Douglas's pouch is removed with a sponge or gauze pad and the abdominal wound closed in the usual way.

It often happens that the operation is not as simple as has just been described, but, on the contrary, the tumour is very adherent to the adjacent parts. Adhesions with the parietal peritonæum are generally easy to free. Other adhesions which contain blood-vessels should be first tied and then divided. Special care is necessary in the case of adhesions with the intestine, and the most difficult to free are those in the pelvis. Superficial hæmorrhage or oozing should be stopped by the application of the thermo-cautery or by sutures. In case the cyst fluid is purulent in character the peritoneal cavity should be drained as described on page 39.

The after-treatment is the same as that of every laparotomy (see page 47), and any disturbance in the normal course of healing is treated in the usual way. In case septic peritonitis develops, one should try to save the patient by opening the peritoneal cavity, washing it out, and draining it (see page 39).

Patients after ovariectomy occasionally develop symptoms of intestinal obstruction from the fact that the intestine becomes adherent to the ovarian pedicle or the peritonæum and is then constricted or flexed. The lumen of the gut may also be closed by fibrous bands, by entrance of the intestine into a hole in the mesentery, or by localized suppuration. The intestine may also be drawn toward or into the abdominal wound. Kaltenbach called attention to the fact that injury to the endothelium of the peritonæum, either by traumatism or the action of irritating antiseptics, easily gives rise to the formation of adhesions, and hence occasionally to intestinal obstruction. Constriction of the intestine may either take place in the first hours or days after the operation or after weeks, months, or years. If symptoms of obstruction appear, laparotomy must be performed as promptly as possible.

In cases where an ovary or tube is only partially diseased one may resect the ovary or tube preserving the normal portions.

For the treatment of inflammations of the ovaries and tubes, particularly pyosalpinx, the reader is referred to text-books of gynæcology.

Castration.—By castration of women in the narrow sense we mean the removal of normal ovaries for the purpose of suppressing ovulation and menstruation. The removal of diseased ovaries is designated as ovariectomy or oöphorectomy. Hegar was the first to give to this operation a scientific foundation and to introduce it into general practice, although Battey was the first to perform it. After the removal of both ovaries menstruation stops, the uterus becomes smaller, and the women are sterile without having lost the sexual function. The views of different men are divided regarding the indications for the operation, and for a more detailed account of the subject I refer to the text-books of gynæcology. The following brief remarks will suffice here:

Castration is indicated in defects or absence of the uterus, in atresia of the genital canal, in diseases of the uterus (myomata, hæmorrhage, dysmenorrhœa, etc.) which can not be cured in any other way, and, finally, in severe nervous and mental diseases which are connected with the sexual functions. The operation has frequently been misused, particularly in neuroses. The final results of the operation are in part favourable, but in some cases permanent success has not been achieved. The most successful cases are those of myoma of the uterus with hæmorrhage. The tumour diminishes in size, and the hæmorrhage usually stops completely. The menopause is not a contra-indication to the operation.

The operation is performed as follows: The abdominal cavity is opened in the median line by a rather small incision. The ovaries, having been found, are tied off by means of two or three ligatures, which include the tube and broad ligament, and removed. In cutting them away care must be taken not to leave any ovarian tissue behind. Some surgeons perform the operation through the posterior vaginal fornix; this method is only possible in the case of movable and not too large ovaries, and has not found many supporters.

CHAPTER XXVIII.

INJURIES AND DISEASES OF THE PELVIS.

Fractures.—Dislocations of the symphysis pubis and the sacro-iliac synchondrosis.—Injuries of the soft parts of the pelvis.—Ligation of the superior and inferior gluteal arteries.*—Aneurisms of the gluteal arteries.—Acute and chronic inflammations of the pelvic bones and articulations.—Coccygodynia.—Inflammations of the soft parts lining the pelvis.—Psoas abscesses.—Iliacal abscesses.—Inflammations of bursa.—Tumours of the pelvis.—Congenital sacral tumours and other tumours and fistulae of the sacro-coccygeal region.—Elevation of the pelvis in laparotomies.—Operations on the bladder, in the pelvis, etc. (see § 214).—Symphysiotomy.

§ 259. **Fractures of the Pelvis.**—Fractures of the pelvis are, generally speaking, rare, and result usually from the action of great violence, such as from being run over, being caught between the buffers of two cars, from railroad accidents, from being buried up, a fall from a great height, gunshot injuries, etc. Fractures of the pelvis have, in rare cases, resulted from muscular action—for example, fracture of the horizontal ramus of the os pubis (Maydl). The latter class of fractures includes also avulsion of the anterior superior and inferior spines of the ilium by the ilio-femoral ligament, or by the sartorius and tensor vaginae femoris muscles. The tuberosity of the ischium may be torn off in the same way, or the crest of the ilium by the action of the gluteal muscles.

As regards the external appearance of a fracture of the pelvis, a distinction is to be made between single and multiple fractures. Among single fractures of a certain circumscribed part of the pelvis fractures of the tuberosity of the ischium should be mentioned. In case the fragment and enveloping periosteum are completely separated, the former may be drawn downward by the flexor muscles of the leg.

Other single fractures are those of the ilium, including its crest and the anterior superior and inferior spines. The anterior superior spine may be displaced downward by the sartorius and the tensor vaginae femoris muscles. In fractures of the crest the same is usually drawn outward by the gluteal, and upward by the transversalis and oblique abdominal muscles.

* The inferior gluteal artery is the German designation for the sciatic.—TRANS.

Single fractures of the acetabulum—of its border, for example—occur most commonly in connection with dislocations of the hip. By a fall upon the great trochanter the acetabulum may be shattered, and the head of the femur pass through the latter into the small pelvis (Fig. 610). As long as the epiphyseal cartilages of the acetabulum persist, separations of the epiphyses are possible, but have been but rarely observed.

In fractures of the acetabulum it is a good plan to make a rectal examination, in order to determine whether the fragments project into the pelvis. The symptoms of fracture of the acetabulum alone are, generally speaking, similar to those of fracture of the neck of the femur (see this). In extensive shattering of the posterior border of the acetabulum similar manifestations are present as in dorsal dislocation of the hip, or the fracture is combined with dislocation.

Fractures of the sacrum alone, particularly transverse fractures, result usually from a fall on the posterior inferior surface of the sacrum. Fractures of the coccyx alone, due to a fall, kick, or blow, are rarer.

More important than the single circumscribed fractures of the pelvis are the multiple ones, of which the following main varieties are distinguished:

1. Fractures of the rim of the pelvis (os ilium and pubis—Malgaigne). These result from the above-mentioned forms of direct violence, and particularly those which act in an antero-posterior direction, and tend to diminish the sagittal and oblique diameters. Besides fractures of the ilium and horizontal ramus of the os pubis, sagittal compression may also give rise to fractures of the ascending ramus of the ischium and diastasis of the sacro-iliac synchondrosis, with forward dislocation of the sacrum or fracture of the transverse processes of the latter, in case the ligaments are strong enough to resist the violence.

2. Double vertical fracture through the ilium, os pubis, and ischium, as well as diastasis of the sacro-iliac synchondrosis, may result from lateral compression of the pelvis. A vertical fracture of the pelvis, combined with other fractures, is shown in Fig. 611. Alreiza has shown by experimental and clinical observation that lateral compression, which is gradually increased, brings about the following results: (1) Straightening of the ilia and lengthening of the antero-posterior diameter of the pelvis; (2) separation of the symphysis and of the sacro-iliac synchondrosis; (3) fracture of the rim of the pelvis, usually

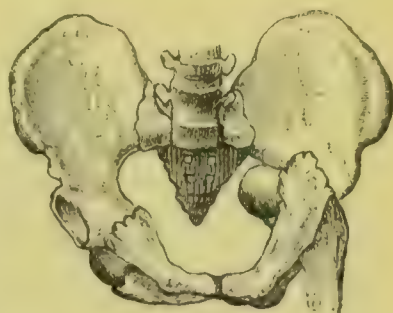


FIG. 610.—Fracture of the acetabulum and passage of the head of the femur into the small pelvis (Hoffa).

the horizontal rami of the pubic bones; (4) fracture, and at the same time displacement, of the symphysis and sacro-iliac synchondrosis.

3. Diagonal compression of the pelvis causes essentially the same injuries as transverse compression—i. e., diastasis of the sacro-iliac

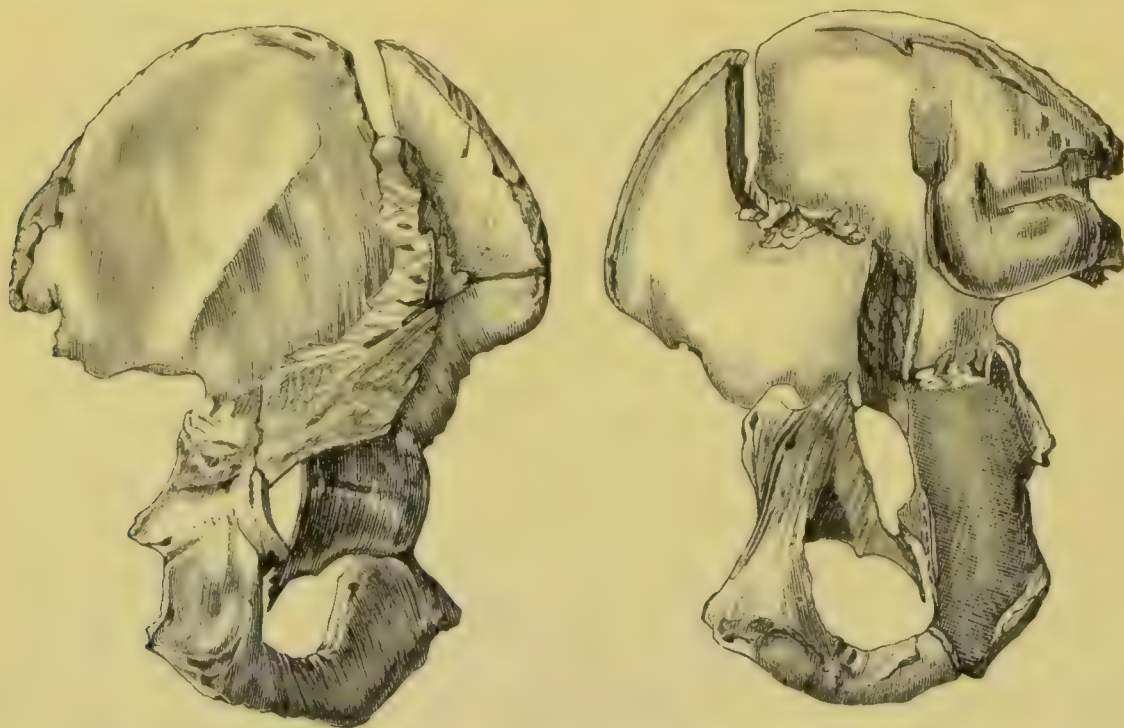


FIG. 611.—Extensive fracture of the pelvis which has partially united (Leisrink).

synchondrosis, or double vertical fracture with or without splintering of the ilium, and more rarely fracture and diastasis of the symphysis.

4. A fall upon the buttocks gives rise in the majority of cases to fractures of the os pubis and os ischium in the vicinity of the obturator foramen and the tuberosity of the ischium, and less commonly to diastasis of the sacrum or the symphysis.

In consequence of the severe, usually direct, violence inflicted, serious associated injuries of the soft parts are generally present—such as contusions and lacerated wounds of the external soft coverings, penetration of the latter by sharp fragments, injuries of the pelvic organs (urethra, bladder, vagina, intestine, rectum), injuries of vessels and nerves (iliac, femoral, obturator, and gluteal arteries and veins, and contusion and laceration of the sacral, sciatic, and anterior crural nerves). There are frequently associated injuries of other parts of the body, including the thoracic and abdominal organs, the spine, the skull, and the brain.

The symptoms of fractures of the pelvis vary, of course, with the location and extent of the injury to the bone. In the description that is to follow we have in mind mainly the severe multiple fractures. Symptoms of shock are very frequently present. In consequence of

the pain, the patient usually avoids every movement of the pelvis and the lower extremities. The soft parts and skin are generally infiltrated with blood. The usual symptoms of fracture (deformity, abnormal mobility, and crepitus) are more or less distinct, depending upon the variety and location of the break in the bone. The last two symptoms of fracture are most readily recognised by compressing the pelvis in its transverse, sagittal, or diagonal diameter and carefully palpating its separate parts. Compression of the pelvis is to be done, of course, cautiously, in order that the fragments which may be in good position are not displaced. Rectal examination is always important. In women one should employ bimanual examination through the vagina and rectum. Examination should be made in every case for any accessory injuries, particularly of the bladder, urethra, intestine, rectum, vagina, and the large vessels. Retention of urine is often present without injury to the urinary organs—e. g., in consequence of shock with paralysis of the bladder. The course and prognosis of a fracture of the pelvis depend largely upon whether and to what extent the pelvic organs are injured—viz., the bladder, urethra, intestine, and blood-vessels. For this reason the prognosis of gunshot fractures is, as a rule, the most unfavourable, because they are usually combined with severe associated injuries of the pelvic organs, and they frequently terminate fatally in consequence of these latter injuries from peritonitis, internal hæmorrhage, sepsis, pyæmia, etc. For a description of the course of these associated injuries of the pelvic organs, particularly the bladder, urethra, intestine, and rectum, and their consequences, the reader is referred to the corresponding paragraphs. Even extensive fractures of the pelvis may unite in from two to three months, usually with displacement, but without marked functional disturbance.

Treatment of Fractures of the Pelvis.—In simple fractures the first step is to attempt to reduce the displacement as completely as possible. The patient should be transported cautiously with the pelvis immobilized. In order to maintain a fractured pelvis in good position, it is often sufficient to keep the patient in bed on his back, with the hips and knees flexed or extended, and the pelvis immobilized by a broad leather belt or elastic bandages. It is also a very good plan to place the patient in Bonnet's wire bed. In fractures of the acetabulum and in vertical fractures of the pelvis an extension splint may be applied to advantage besides immobilizing the pelvis by a broad leather belt or elastic bandages. Compound fractures and resulting suppuration are treated in accordance with general rules. Fresh cases are treated by thorough disinfection and drainage, in order to prevent future suppuration. For a description of ligation of the common, internal, and

external iliac arteries and veins, see § 157, page 32; ligation of the gluteal arteries is described in § 261, page 481. For the treatment of injuries of the bladder, urethra, intestine, rectum, etc., see the corresponding paragraphs. It is of great importance to prevent bedsores by scrupulous cleanliness, cushions filled with air or water, etc. Fractures of the acetabulum are treated by extension in a similar way to fractures of the neck of the femur.

Asymmetry, or unequal development of both halves of the pelvis, results from fractures of the pelvis, dislocations of the symphysis or sacro-iliac synchondrosis, particularly in young growing children, and from chronic diseases of the pelvis and pelvic organs. Asymmetry of the pelvis may also be caused purely by a disturbance in development without traumatism or disease of the pelvis and pelvic organs. The right half of the pelvis in these cases usually surpasses the left in its measurements (Hasse). Such individuals have often either had rhachitis or are suffering from a late form of the same, and scoliosis of the spine is usually present. Asymmetry of the pelvis is also of interest to the obstetrician. The limping gait of patients with this deformity, caused by the difference in the height of the acetabula, is remedied by wearing a high shoe.

§ 260. **Dislocations of the Symphysis and Sacro-iliac Synchondrosis.**—Traumatic separation of the symphysis or sacro-iliac synchondrosis takes the form either of a simple diastasis with more or less marked gaping of these articulations, or it is combined with actual displacement of the bones, with or without fracture of the same. It is only when the bones are really displaced that one can speak of a dislocation of these amphi-arthrooses.

1. **Dislocation of the Symphysis** occurs most frequently during delivery, when the pelvis is narrow, or from a fall or blow upon the symphysis, from violent contraction of the adductor muscles in stumbling, etc. The injury is characterized by pain, abnormal mobility, and inability to walk. One can feel through the skin the more or less marked gap in place of the symphysis. The urethra or bladder are not infrequently injured. In cases combined with fracture of the pubic bones the two fragments may be displaced longitudinally or from in front backward, so that they lie one above the other or one in front of the other.

2. **Dislocation of the Sacro-iliac Synchondrosis** is, as we saw above, usually combined with fractures of the pelvis, particularly of the pelvic brim and vertical fractures. It results usually in such complicated cases from compression of the pelvis in a transverse, sagittal, or diagonal direction. Dislocation alone is usually caused by direct violence applied against the sacrum, which forces the latter forward. Separation of the synchondrosis sometimes takes place on only one side, which

is recognised by inequality in the position of the crests of the ossa ilia or the anterior superior spines. If the symphysis is dislocated at the same time, the whole half of the pelvis may be displaced upward and forward or backward and outward; the leg on that side is shortened and rotated outward. Simultaneous dislocation of all three articulations has also been observed. The characteristic symptoms of dislocation of the sacro-iliac synchondrosis are pain, abnormal mobility in the articulation, and displacement of the bones. The deformity can easily be corrected by traction on the leg, but reappears as soon as the traction is stopped. There are usually serious associated injuries caused by the severe violence inflicted, and the patient succumbs to these.

3. Dislocations of the coccyx may be either anterior or posterior, and the symptoms are in general the same as those of a transverse fracture.

The treatment of dislocations of the symphysis consists in reduction of the fragments and fixation of the pelvis by a broad pelvic belt or strips of adhesive plaster, the patient being in the dorsal position, with the hips and knees flexed. Dislocations of the sacro-iliac synchondrosis are treated essentially in the same way as fractures of the pelvis. Extension is used if necessary and the pelvis immobilized by a belt, strips of adhesive plaster, or elastic bandages. In suitable cases the bones may be fastened in position by sutures or aseptic nails. Dislocations of the coccyx require, as a rule, no special treatment.

§ 261. **Injuries of the Soft Parts of the Pelvis.**—Injuries of the pelvic organs have already been described under their special paragraphs. They include injuries of the peritoneal cavity, intestine, rectum, genito-urinary organs, and the large abdominal blood-vessels (aorta, iliac arteries and veins). We have only to take up here injury and ligation of the superior and inferior gluteal arteries.

Injuries of the Superior and Inferior Gluteal Arteries.—These arteries arise from the internal iliac. The superior gluteal leaves the pelvis at the upper part of the greater sacro-sciatic foramen and above the upper border of the piriformis muscle, while the inferior gluteal emerges below the piriformis muscle, between the internal pudic artery and the sciatic nerve (see page 228, Fig. 507). Injuries of the gluteal arteries from gunshot and punctured wounds are of great practical importance and have in general a bad prognosis. Whenever wounded, these arteries should always be tied, as compression is very uncertain.

Ligation of the superior gluteal between the piriformis muscle and the upper border of the greater sacro-sciatic foramen is performed as follows: The patient lies upon his abdomen with the pelvis elevated and

the leg on that side somewhat abducted. The skin incision runs from the posterior superior iliac spine outward and downward toward the centre

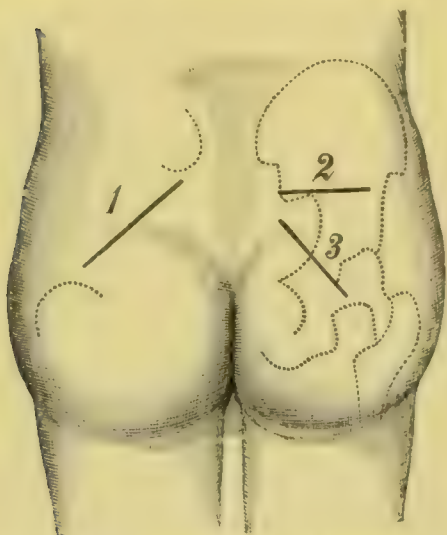


FIG. 612.—Ligation of the superior (1 and 2) and inferior (3) gluteal arteries.

of the posterior intertrochanteric line or to the neighbourhood of the great trochanter (Fig. 612, 1). After dividing the skin, fat, and gluteal fascia, the glutæus maximus is separated with the finger in the line of its fibres and its edges retracted. One now feels in the upper angle of the wound for the edge of the greater sacro-sciatic notch, and divides here the intermuscular space between the glutæus medius and piriformis, whereupon the superior gluteal artery and vein become visible and can be tied close to the sacro-sciatic foramen. The superior gluteal nerve emerges from the pelvis somewhat

below the artery and likewise above the piriformis muscle. Bouisson exposes the upper edge of the greater sacro-sciatic foramen by a transverse incision near the posterior inferior spine of the ilium (Fig. 612, 2).

Ligation of the inferior gluteal is performed at the lower border of the piriformis muscle where it passes out of the pelvis in company with the internal pudic artery, the veins and nerves of the same name, and the great and small sciatic nerves (see page 228, Fig. 507). At this point there are eight vessels and nerves. The skin incision (Fig. 612, 3) begins a finger's breadth below the posterior inferior spine of the ilium, and runs obliquely downward between the greater trochanter and the tuberosity of the ischium. After dividing the soft parts, as in ligation of the superior gluteal, one feels for the lower edge of the piriformis muscle and the great and lesser sacro-sciatic ligaments. The artery lies upon the lesser sacro-sciatic ligament, between this and the lower edge of the piriformis muscle. The sciatic nerve, which can be distinctly felt, is also useful as a guide.

Aneurisms of the Gluteal Arteries are most frequently traumatic, but are sometimes idiopathic. Out of thirty-five cases collected by Fischer, twenty-three were traumatic and twelve idiopathic. In making the diagnosis a rectal examination is often useful. The treatment is the same as for hæmorrhage from these arteries—i. e., ligation. When possible the artery should be tied above and below the sac and the latter slit open (Antyllus). In case of extensive disease of the wall of the artery the internal or common iliac may be tied. Injection of liquor ferri chloridi combined with compression of the sac has resulted in a cure in a number of instances, and this method seems to be entirely without danger and a very good one.

§ 262. **Inflammations of the Bones and Joints of the Pelvis** are either primary or secondary to diseases of the neighbouring organs, or metastatic in the course of pyæmia and certain infectious diseases.

Acute periostitis and osteomyelitis are infrequent. They sometimes occur in the os ilium of young persons, and are characterized by fever and enlargement of the bone. They either go on to complete restitution or to suppuration with necrosis of the external or internal surface or of the whole thickness of the bone. In some cases they result like acute osteomyelitis of the long bones in young individuals in separation of the epiphyses. The pus seldom breaks through the skin directly, but is more likely to descend to the thigh. In rare cases acute osteomyelitis becomes fatal in a few days from sloughing of the cancellous tissue and sepsis.

Traumatic suppuration results usually from compound fractures, particularly gunshot fractures, and of the latter, "circular fractures" run a better course than splintered fractures. In such cases suppuration can easily spread to the pelvic connective tissue and the peritonæum, causing death in a very short time.

The treatment of suppuration of the pelvic bones consists in thorough evacuation of the pus, as described below, in enlarging a gunshot channel, and in removing splinters of bone.

Chronic suppuration of the bones of the pelvis either follows the acute form, and is then usually combined with necrosis, or it is tubercular or, more rarely, syphilitic in origin. Caries of the pelvic bones is the result, in most cases, of tubercular periostitis and osteomyelitis, particularly of the ossa ilia, in the vicinity of the hip joint and the sacro-iliac synchondrosis. It is frequently secondary to tubercular disease in these joints. In some cases very large cold abscesses are formed which spread toward the thigh or rupture into the bladder, the rectum, or the vagina. If tubercular sequestra enter the bladder they may give rise to the formation of calculi. Gummatous periostitis and osteomyelitis in the later stages of syphilis, which can also cause extensive caries, is much rarer than tubercular caries. The same is true of non-tubercular parametric suppuration, which may cause secondary caries of the pelvic bones.

The treatment of chronic suppuration and caries of the pelvic bones is mainly local, consisting in scraping out carious areas with the sharp spoon and removing sequestra by chiselling open the bone. It has become the custom of late, among some surgeons, to perform extensive resections of the pelvic bones, particularly of the acetabulum and os ilium, for tuberculosis and osteomyelitis (Bardenheuer, Bergmann). Caries of the inner surface of the pelvis and intrapelvic ab-

abscesses are exposed by opening the pelvis with the chisel as low down as possible—for instance, above and behind the acetabulum, at the centre of a line joining the anterior and posterior-superior spines, three centimetres in front of the sacro-iliac synchondrosis (Condamin); the abscess may be drained through the perinæum between the tuberosity of the os ischium and the anus, or in the posterior rhaphe near the coccyx and sacrum. If the abscess can be reached from the inguinal region, one should make an incision here and then a counter opening with curved dressing forceps through the great sacro-sciatic notch or through the os ilium in the way just described. In working in deeper, some blunt instrument or the finger should be used, and the position of the large vessels kept in mind. One sometimes finds very long fistulous tracts—on the outer or inner surface of the os ilium, for instance—which should be laid open as completely as possible or drained by means of long drainage-tubes, which are gradually shortened. Large pelvic abscesses can be exposed through the perinæum (Dittel and Zuckerkandl, see pages 330 and 433), or by resection of the coccyx and sacrum, after Kraske. Pelvic abscesses in the female may be reached through the vagina. Laparotomy is often necessary, and the abscess is drained at the most suitable point; the wall of the abscess can sometimes be drawn forward and sutured into the abdominal wound.

Inflammations of the joints of the pelvis have essentially the same etiology as acute and chronic inflammations of the bones. Acute septic processes sometimes occur which are caused by acute osteomyelitis—for example, of the articular ends of the sacro-iliac synchondrosis; moreover, pyæmic and septic inflammation, both of the symphysis and the sacro-iliac synchondrosis, caused by infection from a puerperal endometritis. During pregnancy the joints of the pelvis are sometimes abnormally loose, movable, and painful.

Chronic inflammation and suppuration of the joints of the pelvis are most frequently of tubercular nature. The abscesses which are formed in tubercular inflammation of the sacro-iliac synchondrosis may, in the most favourable cases, rupture posteriorly; but they often pass out of the small pelvis through the sacro-sciatic foramen, spread beneath the gluteal muscles, or make their way down along the psoas muscle to the thigh. The inflammation originates in some cases in the joint between the sacrum and coccyx and between the separate vertebræ of the coccyx.

The treatment of non-suppurative inflammations of the symphysis and the sacro-iliac synchondrosis follows the general rules applicable to other joints. It consists mainly of rest in bed, in immobilization by means of a pelvic belt, the application of ice, etc. In suitable cases

injections of carbolic acid or tincture of iodine are useful. In case of acute and chronic suppuration one must, of course, make an incision, drain, and, if necessary, use the sharp spoon. Tubercular gravitation abscesses should be opened and scraped out, or aspirated and injected with a sterilized ten-per-cent solution of iodoform in oil or a ten-per-cent emulsion of iodoform and glycerin. Injections of iodoform-glycerin and iodoform oil are particularly beneficial in tubercular disease of the pelvis, but the treatment has to be continued for a long time.

For a description of spondylolisthesis see vol. ii, § 147, page 825.

Coccygodynia is characterized by severe pain in the coccygeal plexus and the vicinity of the coccyx (Simpson). The pain, which occurs almost exclusively in women, is increased by the slightest movement of the coccyx, particularly from contraction of the glutæus maximus, the coccygeus, the ischio-coccygeus, the levator ani and the sphincter ani muscles. This affection, which is often very obstinate, is due to various causes, such as fracture and dislocation of the coccygeal vertebræ from a fall, kick, forceps delivery, etc., or inflammatory processes in the bone, the joints of the coccyx or its vicinity. In many cases there is no special cause to be found, and we have to deal merely with neuralgia.

The treatment depends mainly upon the cause. If no cause can be found one should employ narcotics, particularly hypodermic injections of morphine, and antiphlogosis. Good results have been obtained by subcutaneous division of the muscles and ligaments that are attached to the coccyx, particularly the glutæus maximus and sphincter ani. The surest method of bringing about a permanent cure consists in excision of the coccyx by an incision from the tip of the coccyx upward. After freeing the bone from all its connections, particularly on the side, it is cut off with bone-cutting forceps or separated from the sacrum by carrying the knife through the articulation with the latter.

§ 263. **Inflammations of the Soft Parts lining the Pelvis.**—The most important of these is inflammation of the psoas major muscle, called psoitis. As already seen in vol. ii, § 146, page 816, psoitis is ordinarily a secondary inflammation, resulting from tubercular spondylitis of the dorsal and upper lumbar vertebræ, from caries of the ilium and the sacro-iliac synchondrosis, or from an abscess in the vicinity of the cæcum, the bladder, or the uterus. Primary inflammation of the psoas muscle is extremely rare, but its occurrence can not be denied. Secondary tubercular psoitis sometimes occasions very large collections of pus. The pus either follows the connective tissue in the vicinity of the muscle or it is found also in the intermuscular septa between the muscular fibres. The course taken by psoas abscesses has been carefully studied and described by König. They usually perforate above or below Poupart's ligament by raising up the peritonæum covering the

iliacus and psoas major muscles; more rarely they perforate the scrotum or leave the pelvis posteriorly through the greater sciatic foramen, or rupture into the intestine, rectum, or bladder. They often appear on the anterior surface of the thigh, at the inner border of the psoas major, or among the adductors, as far down as the knee. In a good many cases the pus spreads more in an outward direction and follows the iliacus muscle. Other abscesses point in the buttocks or in the lumbar region near the quadratus lumborum muscle. They occasionally rupture into the hip joint by first involving the iliac bursa (see § 314, Hip joint).

All abscesses that spread along the psoas muscle result at a comparatively early date in contracture of the thigh, so that they can be easily mistaken for hip disease. In the differential diagnosis any spondylitis or kyphosis of the spinal column is important as well as the presence of fistulæ in the region of the pelvis while the hip joint itself is not diseased. The genuine psoas abscesses following spondylitis are to be strictly distinguished from iliacal abscesses due to tuberculosis of the ilium, the ilio-sacral synchondrosis, the lower lumbar vertebræ, or to perforation of a coxitis through the acetabulum into the pelvis. Iliacal abscesses are characterized by swelling of the inner surface of the ilium corresponding to the position of the muscle.

All psoas abscesses wherever they point should be incised under antiseptic precautions, scraped out, and drained. There is not much danger of wounding the peritonæum, as it is usually lifted up by the abscess. Of late, good results have been obtained by aspiration of the abscesses and injection of ten-per-cent iodoform-glycerin or ten-per-cent iodoform oil.

For a description of sacculated intraperitoneal inflammation and suppuration, parametritis, and perimetritis, see page 36 (Peritonitis). In suitable cases suppurative processes in the pelvis may be reached through the vagina, through the perinæum by the Dittel-Zuckerkanndl method (see pages 330 and 433), from behind with resection of the coccyx and sacrum, after Kraske (see page 172), or, finally, by chiselling through the ilium as low down as possible—e. g., behind the acetabulum (see page 484). Schuchardt's perineo-vaginal incision (see page 469) may also be employed. Recent puerperal exudates should be evacuated as promptly as possible through the vagina and the wall of the abscess sutured all round to the mucous membrane of the vagina (Fritsch). In chronic periuterine suppuration laparotomy or vaginal hysterectomy may be necessary (Müller, Péan, Segond, and others).

Inflammations of the Pelvic Bursæ.—Inflammations of the numerous bursæ of the pelvis are not common. Hueter found a number of rice bodies

in the large bursa over the tuberosity of the ischium. This bursa sometimes becomes inflamed in consequence of bedsores and gives rise to progressive inflammation and suppuration in the deep intermuscular connective tissue. Inflammation and suppuration of the bursæ between the skin and posterior surface of the sacrum and coccyx are the most common. Suppurative inflammation of these bursæ with the formation of fistulæ may be mistaken for fistulæ in ano.

Removal of Tubercular Glands from the Pelvis.—One is often obliged to remove tubercular glands in the inguinal region which extend deep down into the pelvis. For this purpose Sprengel's method of operating is to be recommended. After removal of the tubercular inguinal glands, Poupart's ligament is divided through a longitudinal incision, the femoral artery and vein are exposed, and an oblique incision is made outwardly along Poupart's ligament in order to be able to push back the peritonæum. In this way the large vessels of the pelvis lie exposed, and if the pelvis is elevated it is possible to keep in sight of these vessels and remove the tubercular glands as far as the bifurcation of the common iliac artery.

§ 264. **Tumours of the Pelvis** are, generally speaking, rare. The most common ones are the sarcomata which develop from the periosteum or medulla, particularly the very vascular pulsating myeloid sarcomata; furthermore, chondromata and osteomata. Pelvic sarcomata may attain an enormous size, and are usually characterized by a very rapid growth. I recently saw an inoperable melano-sarcoma of the ilium as large as a man's head in a woman forty-eight years old. Traumatism seems to play an important part in the production of tumours of the pelvic bones. If we exclude pure osteomata, the prognosis of enchondromata is the most favourable and that of the periosteal medullary sarcomata the least favourable; the circumscribed myeloid sarcomata are less malignant than the latter. All pelvic tumours should be extirpated as promptly as possible. I removed with success an osteochondroma of the ascending ramus of the ischium as large as the fist in a young man of twenty, which had begun to develop three years before in consequence of a fall upon the buttocks, probably with partial fracture of the ascending ramus of the ischium. Billroth removed an enchondroma the size of a child's head from the same region, which filled the true pelvis completely and caused symptoms of intestinal obstruction. The patient died on the seventh day in consequence of suppuration. Volkmann removed a myeloid sarcoma of the left side of the sacrum by exposing the tumour from behind and chiselling it out through sound bone. The sacral canal was removed from the second intervertebral foramen as far as the coccyx, the right half of the sacrum was preserved, and healing took place without special disturbance. Gussenbauer has described several cases of tumours of the pelvis and operated upon them, in part with good success (see *Zeitschrift für*

Heilkunde, Bd. xxi, S. 473). Sarcomata of the pelvic bones—for example, the ilium or the vicinity of the sacro-iliac synchondrosis—usually come for treatment too late, when operative measures are no longer possible. In case of intestinal obstruction, enterostomy may be necessary.

Of parasitic tumours, echinococcus cysts are the most frequent (see Fig. 613). Echinococcus cysts of the bone, which develop mainly in the medulla and sometimes as the result of a trauma, are usually slowly growing, indolent tumours, which

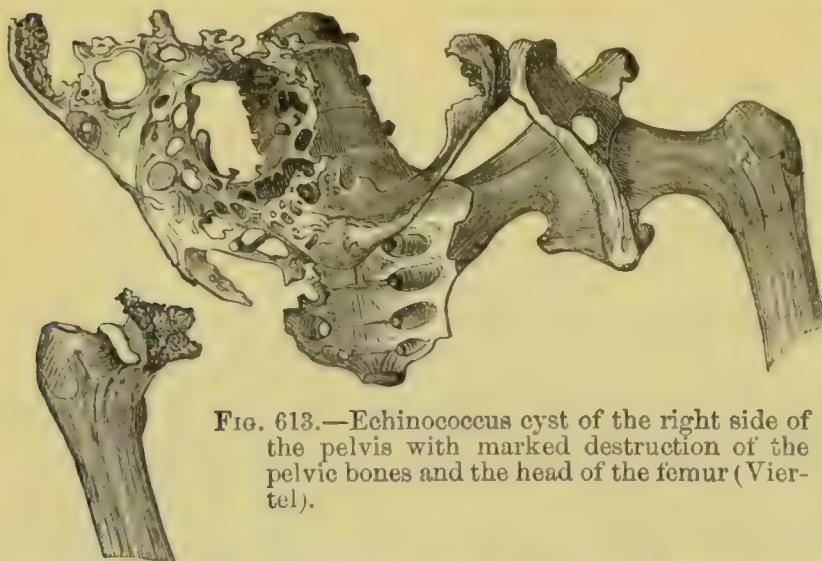


FIG. 613.—Echinococcus cyst of the right side of the pelvis with marked destruction of the pelvic bones and the head of the femur (Viertel).

may remain latent for a long time and are sometimes painful in the later stages. The multilocular or diffuse form is by far the most frequent; of thirty-seven cases collected by Gangolphe, thirty-two were multilocular and only five unilocular. Of fifty-two cases of echinococcus cysts of bones, twenty-six involved the long and eighteen the flat bones, and of the latter the pelvis eleven times. The diagnosis of an echinococcus cyst of the pelvis, which sometimes gives rise to marked destruction of the bone (see Fig. 613), can be made with certainty only when the soft, fluctuating cyst has broken through the bone or some of its contents can be obtained by an exploratory puncture. The prognosis of an echinococcus cyst of the pelvis is, generally speaking, unfavourable. The treatment consists in the earliest possible and most complete removal of the inflammatory focus by means of the hammer and chisel, sharp spoon, Paquelin cautery, etc. Echinococcus cysts of the pelvic cellular tissue are very rare.

Congenital Sacral Tumours are of considerable interest, and we are particularly indebted to Virchow and Duplay for our knowledge of them. They have a very varied origin. Some of them are genuine teratomata—i. e., cystic formations which contain cartilage, bone, rudimentary coils of intestine, brain matter, nerves, muscles, and glandular structure. We have to do in these cases with a parasitic

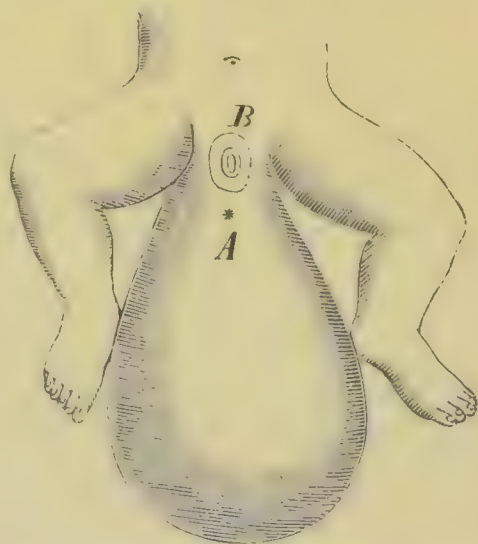


FIG. 614.—Congenital sacral tumour with displacement of the anus: A, anus; B, external genitals.

monster, or a *fœtus in fœtu*, and the tissues found in the tumour are to be regarded as rudimentary portions of the skeleton and organs of an inclosed stunted fœtus. In other cases these different tissues in the tumour are to be regarded merely as strayed germs which were taken up and surrounded by the organism (*inclusio fœtalis*). Such teratomata sometimes form very large tumours situated in the region of the sacrum and coccyx (Fig. 614). The "Schliewener child" with a contractile sacral tumour, described by Virchow, is particularly well known (Fig. 615). These rudimentary formations or fœtal inclusions occur also in other parts of the body—for example, in the buccal cavity, in the brain, in the abdominal cavity, etc. Dermoid cysts also belong among the teratoid tumours or fœtal inclusions. The Siamese twins are the best-known example of a complete duplication of the body, or genuine double monster. Partial duplications of single parts of the body, such as the head or the extremities, are very manifold. Besides these *fœtuses in fœtu* and dermoids, there are other tumours of the coccygeal region containing various tissues which are to be regarded as fœtal rudiments of this part of the body—i. e., derivatives of a fœtal neural and intestinal canal or spinal column (A. Ritschl).

Another category of congenital sacral tumours has an entirely different etiology. This includes the various forms of spina bifida, or congenital protrusion of the contents of the spinal canal, the result usually of gaps in the vertebral arches (see vol. ii, § 139, page 757 ff.). Other congenital tumours are those due to degeneration of Luschka's coccygeal gland, and furthermore congenital lipomata and lymphangiomas, which usually have their origin between the sacrum and the rectum. Braune mentions in addition the following forms of congenital sacral tumours: 1. Sacral hygromata, which are sessile cysts of the posterior sacral region, and are in some cases to be regarded as spinæ bifidæ which have ceased to communicate with the spinal canal. 2. Coccygeal tumours which develop on the anterior surface of the coccyx and sacrum, and form pear-



FIG. 615.—The "Schliewener child" with a contractile sacral tumour (Virchow).



FIG. 616.—Pseudo-caudal appendage (lipoma pendulum caudiforme).

shaped growths between the anus and coccyx; they result from sarcomatous degeneration of the dura, from proliferation of remains of the chorda dorsalis, or from degeneration of Luschka's coccygeal gland.

3. Caudal and lipomatous appendages. The very rare genuine caudal appendages are caused by increase in the number or size of the coccygeal vertebræ while the pseudo-caudal appendages are cylindrical pouches of skin containing fat or are true lipomata, as in Fig. 616.

Nasse divides congenital coccygeal tumours into (1) simple dermoids, (2) complex dermoids, (3) cysto-sarcomata, and (4) teratomata. The tumours lie either on the dorsal or ventral surface. The development of ventral cysts or teratomata bears a definite relation to the caudal gut, and hence these cysts never communicate with the spinal canal. The congenital cystic tumours, involutions of the skin and fistulæ in the region of the dorsal surface of the sacrum and coccyx, are to be regarded as disturbances in the development of the medullary tube or central canal of the spinal cord. Wette distinguishes among congenital involutions of the skin or fistulæ in the sacro-coccygeal region three main varieties: (1) A simple involution of the skin ("fovea sacro-coccygea"), (2) a sacro-coccygeal fistula and (3) an epidermoid sacro-coccygeal cyst. The cutaneous lining of these involutions or fistulæ sometimes contains hair-follicles, hairs, and sebaceous and sweat glands, while in other cases these are entirely absent. The fistulæ sometimes terminate in the spinal canal. Riedel observed an extradural dermoid of the latter, with an external fistulous tract; the fistula terminated in the spinal canal but apparently did not communicate with the sac of the dermoid, which was nearly the size of a walnut.

An exact diagnosis of the different tumours of the sacro-coccygeal region is often very difficult. One should always determine, in the first place, whether the tumour is in open communication with the central canal of the spinal cord—i. e., whether it is a spina bifida. A rectal examination often gives important information. Children with true congenital teratomata usually die in from six months to a year. Sacral tumours are much more common in females than in males. Sacro-coccygeal dermoids may from some unknown reason, or from the effects of a traumatism, become complicated by inflammation, suppuration, and fistulæ, and in such cases there may be great difficulty in making the diagnosis, particularly if the patient knew nothing of the previous existence of a tumour (Gussenbauer).

The treatment of sacral and coccygeal tumours depends upon the variety. The easiest tumours to extirpate are the caudal appendages and the dorsal cysts which have ceased to communicate with the spinal canal. Even before the present period of antiseptic and aseptic surgery tumours of this region were successfully removed in a great many cases. Out of twenty cases of congenital sacral cysts, cysto-sarcomata,

and sarcomata, seventeen were cured and three died. The operation for the removal of cysts on the ventral surface which extend well up into the pelvis may be very difficult, so that complete extirpation is impossible; it may be necessary to expose the field of operation in the same way as for excision of the rectum (see page 170 ff.). In case of cystic formations one may attempt puncture with or without subsequent injection of tincture of iodine. For the treatment of spina bifida see vol. ii, § 139, page 760 ff.

Tumours of the Gluteal Region.—Echinococcus cysts have been observed several times, some of them developing in the gluteal region and others growing outward from the pelvis or the pelvic bones. The treatment consists in incising, emptying, and draining the sac, and, when possible, extirpating the same.

Other tumours that occur in this region are sebaceous cysts, lipomata, and soft fibromata and neuro-fibromata, which frequently reach an enormous size. These tumours are removed in accordance with general principles.

Symphysiotomy.—This operation, which consists in division of the pelvis through the symphysis, has come into use again a good deal in place of Cæsarean section or embryotomy. For a description of the operation the reader is referred to the text-books of obstetrics.

SIXTH SECTION.

SURGERY OF THE UPPER EXTREMITY.

CHAPTER XXIX.

INJURIES AND DISEASES IN THE REGION OF THE SHOULDER.

Injuries in the region of the shoulder: Fractures and dislocations of the clavicle.—Fractures of the scapula.—Fractures of the upper end of the humerus.—Dislocations of the shoulder joint.—Other injuries of the shoulder joint (contusion, sprain, gunshot wounds and other wounds).—Injuries of the vessels in the axilla (injury and ligation of the subclavian artery and vein, see vol. ii, §§ 89 and 90, pages 510 ff and 517 ff).—Aneurisms.—Injuries of the brachial plexus.—Paralysis of the serratus magnus and other paralyses in the region of the shoulder.—Neuralgia of the brachial plexus.—Stretching of the same.

Diseases in the region of the shoulder: Malformations.—Defects and absence of the clavicle.—Congenital displacement of the scapula.—Congenital dislocations of the shoulder.—Paralytic loose joint.—Arthrodesis for loose joint.—Diseases of the bursæ of the shoulder.—Diseases of the shoulder joint.—Inflammatory processes of the axilla, the clavicle, and the scapula.—Tumours in the region of the shoulder.—Resection and complete excision of the clavicle and the scapula.—Resection of the shoulder joint.—Disarticulation of the humerus.—Technique of bandaging the shoulder; see also Principles of Surgery, §§ 50–55.

§ 265. **Fractures of the Clavicle.**—Fractures of the clavicle are rather frequent. They constitute from fourteen to sixteen per cent of all fractures, and are observed especially among children. They arise almost always from indirect violence—e. g., from a fall, a thrust, or a blow upon the outer surface of the shoulder, from a fall upon the hand or the elbow, from lifting heavy loads, rarely from muscular action, as in striking with a whip, in throwing, or springing upon a horse. The fractures of the clavicle from direct violence are much less common than the indirect. The fracture is almost always unilateral, and is found most frequently at the middle third or at the boundary between the outer and the middle thirds, then at the outer third, and most rarely of all at the inner third near the sternal end. The fracture is not infrequently incomplete—i. e., of the green-stick variety, with increased curvature or angular deformity of the bone,

accompanied by swelling and pain on pressure, or upon raising the arm above the horizontal.

The symptoms of fractures of the clavicle vary according to their location.

1. **Fractures at the Middle of the Clavicle.**—These are mostly oblique fractures. If the periosteum is not torn, or if the fractured ends are impacted, the displacement is slight. In other cases there is usually a typical displacement—that is, the fragments override in consequence of the action of the subclavius muscle, and there is an angular deformity with the angle pointing upward (Fig. 617). The sternal end of the clavicle is drawn upward by the sterno-mastoid muscle, while the acromial end is displaced downward by the weight of the arm and the action of the pectoralis major. This deformity is more or less distinct in different cases. The clavicle is correspondingly shortened. When pressure is applied at the site of the fracture the patient complains of pain, and also when he attempts to raise his arm above the horizontal. The latter movement is therefore correspondingly restricted. The arm is rotated inward and adducted, and the head is usually inclined toward the injured side in order to relax the sterno-mastoid muscle. On palpation, one can usually make out, without difficulty, a localized point of tenderness, the deformity, the abnormal mobility, and crepitus. Crepitus is most easily detected by raising the arm above the horizontal. In incomplete and impacted fractures abnormal mobility and crepitus are of course absent.

2. **Fractures of the Clavicle at its Outer Third.**—These arise mainly from direct violence. The more the soft parts, the periosteum, and particularly the ligaments, are torn, the more pronounced is the deformity or the displacement of the fragments. The displacement consists here also in a more or less marked angular position, amounting, it may be, to a right angle, because the acromial end sinks downward from the weight of the arm, and at the same time the outer fragment is drawn in an upward direction by the trapezius muscle. Otherwise the same symptoms are present as those just described for fractures at the middle of the clavicle.

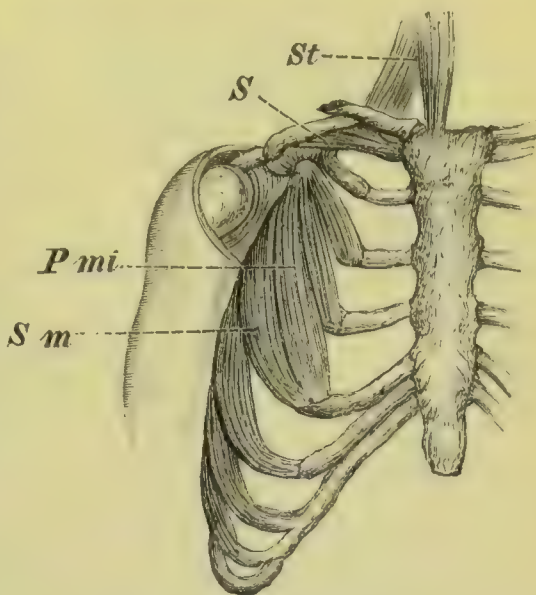


FIG. 617.—Fracture of the clavicle at its middle third: *St*, sterno-mastoid muscle; *S*, subclavius muscle; *P mi*, pectoralis minor muscle; *S m*, serratus magnus muscle (diagrammatic).

3. **Fractures at the Inner Third of the Clavicle** are the most rare. They arise chiefly from indirect violence, and sometimes also from the action of the sterno-mastoid muscle. There is usually no displacement of the fragments except when the costo-clavicular ligament and the muscular insertions are ruptured, in which case the inner end of the outer fragment is elevated in consequence of the weight of the arm or the shoulder, while the acromial end is correspondingly depressed.

Complications in fractures of the clavicle are rare. Injuries of the brachial plexus, the subclavian artery and vein, and the lungs have been observed only in exceptional cases—e. g., in comminuted fractures.

The prognosis of fractures of the clavicle is altogether favourable. Complete bony union ensues in children in from two to three weeks, and in adults in from three to five weeks, without functional disturbance. Pseudarthrosis is rare. The displacement can not be wholly overcome, sometimes, and the fracture unites with deformity, but usually without functional disability. In case of a hypertrophic callus or "bridge callus"—i. e., when there is bony union between the callus and the first rib, the coracoid process or the upper border of the scapula—elevation of the arm above the horizontal may be interfered with, because the movement of the clavicle in its articulations is thereby rendered impossible.

Treatment of Fractures of the Clavicle.—A great number of dressings has been recommended for the treatment of fractures of the clavicle. If there is no displacement, the application of a sling is sufficient (see



FIG. 618.—Bandage for fracture of the left clavicle.



FIG. 619.—Velpéau's bandage with a pad in the axilla for fracture of the clavicle.

Principles of Surgery, page 197, Fig. 155), which may be secured, in the case of uneasy children, by a few turns of a mull or gauze bandage of moderate width about the thorax. These turns of bandage may be smeared with water-glass, whereby the dressing is made very secure. The displacement, if present, is overcome by drawing the shoulder outward, backward, and then upward, as well as by pressure at the site

of the fracture. Reduction of the displacement is most successfully accomplished with the patient lying on his back, and it is often advisable to put on the bandage in this position. The following dressing is

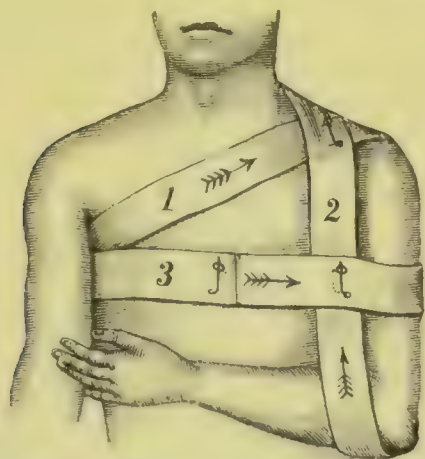


FIG. 620.—Treatment of fracture of the clavicle with rubber bandages.

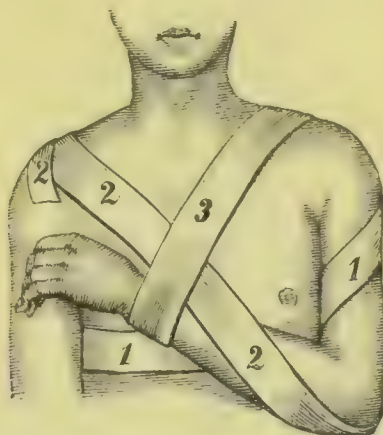


FIG. 621.—Sayre's adhesive-plaster dressing for fracture of the clavicle.

very serviceable: A good-sized wad of cotton, or a small wedge-shaped cushion is put in the axilla, the arm placed in a sling, cotton applied to the site of the fracture, and the whole fastened in place by bandages around the thorax, the shoulder, and the upper arm, with or without water-glass or plaster of Paris. One can also retain the fracture in a good position by means of an India-rubber bandage or tubing, which is fastened in front to the forearm and to an abdominal belt behind. The dressings represented in Figs. 618–621 are also very useful. Their application is clear from the illustrations. The following may be said, however, with reference to the application of Sayre's adhesive-plaster



FIG. 622.—Desault's bandage.

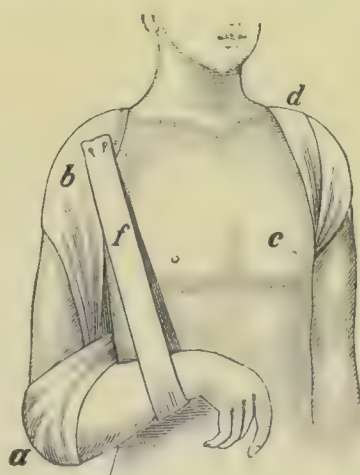


FIG. 623.—Moore's bandage for fractures and dislocations of the clavicle.

dressing: The strips are about three fingers' breadth in width. The first strip (Fig. 621, 1) begins on the inner side of the middle of the upper arm, runs obliquely over the outer side of the upper arm, the

back, and the lower part of the chest, and ends near the mammary line on the injured side. The second strip runs from the sound shoulder

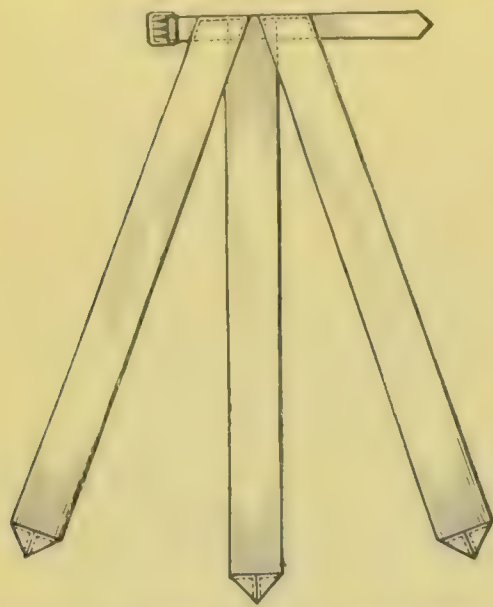


FIG. 624.—Elastic T-bandage for fracture of the clavicle.

obliquely across the chest, the elbow, which is bent at a right angle or an acute angle, and then across the back again to the well shoulder. The third strip serves as a sling to the hand. It begins near the site of the fracture, runs across the front of the chest, around the wrist, and then back to the injured shoulder. Desault's bandage, which was formerly much employed, is but little used at present (Fig. 622). A wedge-shaped pad is first fastened in the axilla on the injured side by circular turns around the thorax, and the arm is then secured over the pad likewise by means of circular turns

about the chest. Finally, the following turns are made: The bandage is carried from the axilla on the sound side across the chest to the injured shoulder (Fig. 622, 1), then behind to the elbow of the injured side, and from here to the sound axilla (Fig. 622, 2), then across the back to the injured shoulder and down to the elbow (Fig. 622, 3), and, finally, across the back again to the opposite axilla. These turns, as just described, are repeated twice, and a final turn is made from the well shoulder down to the wrist (Fig. 622, 4), around the wrist and up to the injured shoulder (Fig. 622, 5), where the bandage is fastened.

E. M. Moore's bandage (Fig. 623) is used a good deal for fractures and dislocations of the clavicle. A piece of cloth from two and a half to three metres long and eight inches wide is folded together like a cravat, placed with its centre beneath the elbow, and carried from *a* across the dorsal side of the latter and forward over the shoulder to *b*, and from there across the back to *c*, the axilla of the well side. The other end runs from *a* across the anterior aspect of the elbow and across the back to *d*, to be united here with the end coming from *c*. A sling, *f*, elevates the forearm slightly. Büngner's bandage is based upon the same principles, use being made of an elastic T-bandage in three parts (see Figs. 624–626). The transverse strip, which is sixty centimetres long and four centimetres wide (Fig. 624), is carried around the well shoulder and fastened with a buckle. The middle one of the three longitudinal strips (one hundred and twenty centimetres long and ten centimetres wide) is passed across the back and through the axilla, around the upper part of the upper arm on the injured side and back to the place of starting where the end is secured. The arm is in this way drawn backward (Figs. 625 *a* and 626 *a*). The lower strip is applied in the same

way but farther down around the elbow, in order to draw the arm backward and to raise it (Figs. 625 *b* and 626 *b*). The uppermost strip (Figs. 625 *c* and 626 *c*) descends to form a sling at the wrist, and then passes over the site

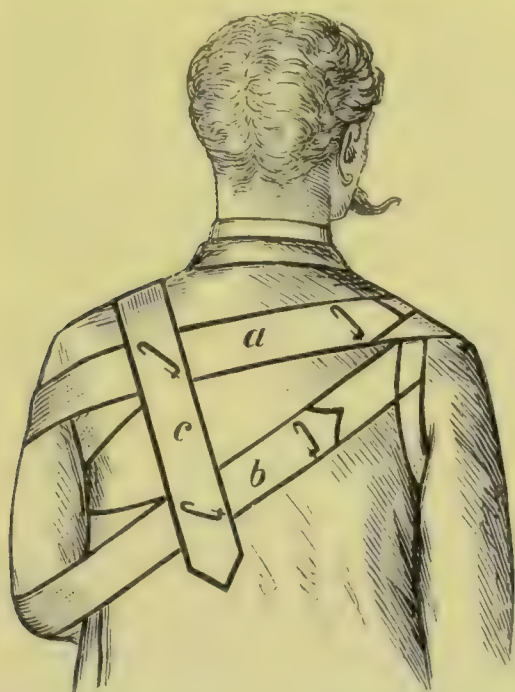


FIG. 625.—Büngner's bandage for fracture of the clavicle; posterior view.



FIG. 626.—Büngner's bandage for fracture of the clavicle; anterior view.

of the fracture and the injured shoulder, pressing down the fragments, and is fastened behind to the first two strips, *a* and *b* (Fig. 625).

The patient need keep his bed only in case of fracture of both clavicles and in case of complicating injuries. For such cases Bardenheuer recommends permanent extension (see *Deutsche Chirurgie Lieferung*, 63 a, p. 44 ff.). Accessory injuries are to be treated according to their nature. In obstinate cases with marked displacement and in compound fractures, with or without comminution, suture of the fragments with silkworm gut or silver wire may be advisable. Hypertrophic and "bridge" calluses which press upon the brachial plexus and the vessels are removed with hammer and chisel. In case of pseudarthrosis the fractured ends are freshened and sutured.

§ 266. **Dislocations of the Clavicle.**—The clavicle is joined to the sternum by means of the sterno-clavicular articulation and to the acromion process of the scapula by the acromio-clavicular articulation. In the former joint there is always a fibrocartilage between the two articular surfaces, but this is not constant in the latter joint. Both articulations are surrounded by stout ligaments. Both clavicular joints are to be regarded in a sense as accessory articulations of the shoulder joint, as they permit elevation of the arm above the horizontal. The shoulder joint only allows the arm to be raised up to the horizontal. Further

elevation of the arm is accomplished by movement of the clavicle in the acromio-clavicular articulation, and at last in the sterno-clavicular articulation.

The dislocations of the clavicle occur most frequently at its acromial end, and may be either upward or downward (supra-acromial and infra-acromial dislocation). At the sternal end dislocations are observed in a forward direction (presternal dislocation), in an upward direction (suprasternal dislocation), and in a backward direction (retrosternal dislocation). Dislocation of both ends of the clavicle occasionally occurs.

A. Dislocations of the Acromial End of the Clavicle.—1. Upward dislocation upon the acromion (supra-acromial dislocation). This dislocation, either complete or incomplete, is the most frequent of all dislocations of the clavicle, and in fact is more common than all the others combined. It constitutes, according to the statistics of Krönlein and Gurlt, from 2·4 to 2·7 per cent of all dislocations. It occurs chiefly from a direct blow upon the scapula from above downward, from a blow upon the shoulder from behind with a forward movement of the same, from a fall upon the shoulder or the back, etc. The scapula is,



FIG. 627.—Upward dislocation of the acromial end of the clavicle.

properly speaking, the dislocated part. The dislocation can be produced experimentally only after severing the coraco-clavicular and the acromio-clavicular ligaments (Defranchesi). Incomplete dislocations are most likely to occur when the coraco-clavicular ligaments are preserved.

The symptoms are very characteristic, especially in complete dislocation (Fig. 627). The acromial end of the clavicle projects distinctly upon the acromion, the outer border of the trapezius muscle is very prominent, the head is sometimes inclined to the injured side, and the shoulder is displaced downward, inward, and forward. Elevation of the arm above the horizontal is interfered with, so that the patient can not lay his hand upon his head, for example. Dislocation is sometimes combined with fracture of the clavicle (see § 265, page 492 ff.).

The reduction of a supra-acromial dislocation of the clavicle by drawing back both shoulders and by direct pressure upon the dislocated acromial end of the clavicle is usually easy, but its retention is difficult, so that a corresponding deformity usually results, a fact to which the attention of the patient should be called at the beginning of the treatment. The greater the deformity that remains the more is

the function of the arm impaired, especially for heavy work. Labouring men in particular may be seriously handicapped in their work, as they can no longer lift heavy burdens to the level of the shoulder. Most of the older methods employed for retaining the dislocated bone in position are of little effect, such as, for example, elastic bandages, pad pressure, or other pressure appliances. An India-rubber band or India-rubber tubing fastened in front on the forearm and to an abdominal belt behind is perhaps the best means of immobilization. A sling is worn at the wrist. The best way is, no doubt, to secure the dislocated bone by suture—e. g., of the ruptured ligaments or the bone. In old dislocations one may freshen the clavicle and acromion and unite them with silver wire in order to secure bony union. Baum secured complete success in one case by subcutaneous suture so that the workman recovered the normal use of his arm. He carried a suture of silk through the acromio-clavicular ligament and one through the coraco-clavicular ligament, reduced the dislocation, and tied the sutures over a roll of adhesive plaster.

2. Downward dislocation of the acromial end of the clavicle (infra-acromial or subacromial dislocation). This very rare dislocation results usually from a blow upon the outer end of the clavicle, from a fall upon the elbow when the shoulder is fixed, etc. The acromial end of the clavicle lies below the acromion upon the capsule of the shoulder joint or even below the coracoid process, especially when the latter is fractured.

The symptoms of subacromial dislocation of the clavicle are likewise very distinct. The acromial end of the clavicle is not in its normal place, and the acromion itself projects distinctly, so that the articular surface can be felt. The acromial third of the clavicle is directed downward and the outer end of the clavicle is felt in an abnormal position below the acromion. Active and passive movements of the shoulder and the arm are painful and elevation of the arm is especially interfered with.

Reduction is accomplished by drawing back the shoulder or by outward traction on the latter or the arm and by direct pressure upon the clavicle from below upward and forward. In some of the cases retention has been permanent, but even when the bone can not be kept in position and the displacement persists, the functional disturbances which result are very slight, or they may be entirely absent, as a new articulation is gradually formed between the clavicle and the lower surface of the acromion.

B. Dislocations of the Sternal End of the Clavicle.—1. Forward dislocation (presteral dislocation). This is the most common dislocation

of the sternal end of the clavicle, and is sometimes complete and sometimes incomplete. In case of complete dislocation the sternal end lies upon the anterior surface of the sternum, somewhat below the sterno-clavicular articulation, and upon the sternal portion of the sterno-



FIG. 628.—Forward dislocation of the sternal end of the clavicle.

mastoid muscle (Fig. 628). The interarticular fibro-cartilage either remains within the sterno-clavicular articulation or is dislocated with the end of the clavicle. The dislocated sternal end of the clavicle is plainly visible and can be felt on the anterior surface of the sternum, while there is a corresponding gap in place of the articulation. The line of the clavicle deviates somewhat downward. The shoulder is depressed and ad-

ducted, the distance from the acromion to the middle of the interclavicular notch is diminished, the head is slightly inclined toward the injured side in consequence of the tension of the sterno-mastoid muscle, and the insertion of the latter on the clavicle projects sharply. Of the normal movements of the shoulder joint, elevation of the arm above the horizontal is especially impeded. Among complications there may be mentioned rupture of the skin over the dislocated bone and fracture of the upper ribs, the coracoid process, and the acromion.

This dislocation is caused usually by undue backward movement of the shoulder from a blow or a fall, from being run over or from carrying a heavy load, and rarely from muscular action. There is sometimes at first an upward dislocation into the interclavicular notch, and the dislocated bone is then carried downward upon the sternum in consequence of a secondary movement.

Reduction of a presternal dislocation of the clavicle is usually easy, but its retention is scarcely ever successful. If the dislocation is not reduced, full use of the arm is usually recovered in spite of this. Reduction is commonly made as follows: The patient sits astride a chair and the surgeon draws both shoulders outward and backward, while at the same time he presses his knee into the patient's back between the two scapulæ and forces back the dislocated bone from in front into the joint. For maintaining the end of the bone in position use has been made of pressure with the pad of a trusslike bandage passed through the sound axilla (Nélaton). See also Bandages for Fractures of the Clavicle (§ 265, pages 494–497). Under some circumstances the attempt will be made to secure the bone in place by suture or to resect the dislocated end.

2. Upward dislocation of the sternal end of the clavicle (suprasternal dislocation). In this very rare dislocation the sternal end of the clavicle rests in the interclavicular notch in front of the trachea. Dyspnoea is therefore usually present, in case of complete dislocation, and speech may be interfered with in consequence of pressure upon the recurrent laryngeal nerve, causing paralysis of one vocal cord. The clavicle deviates in an upward direction, the shoulder is displaced inward and downward, and movement of the shoulder joint, particularly elevation of the arm above the horizontal, is restricted. There is an increased space between the first rib and the clavicle. The dislocation may arise, as was mentioned above, from the action of the same sort of violence as that causing the presternal dislocation, into which it may pass secondarily.

Reduction is accomplished by drawing the shoulder outward and backward and by direct pressure downward upon the dislocated bone. Retention is usually impossible here also, but no appreciable functional disability of the arm is conditioned thereupon. In case of pressure upon the trachea or upon the recurrent laryngeal and vagus nerves, the bone should be secured in place by suture or resected.

3. Backward dislocation of the sternal end of the clavicle (retrosternal dislocation). Malgaigne collected eleven cases of this rare dislocation. The sternal end of the clavicle lies behind the upper portion of the sternum, and the origin of the sterno-hyoid and sterno-thyroid muscles, less often, still higher up. The higher the dislocated bone reaches, the more likely is it to be felt behind the sternum. A depression is felt in the region of the sterno-clavicular articulation, as the head of the clavicle is wanting at its normal place. Dyspnoea and dysphagia may exist in consequence of pressure upon the trachea and the œsophagus. The radial pulse in the injured arm is diminished in case of pressure of the dislocated bone upon the subclavian artery, and severe brain symptoms, amounting to coma, have been observed from compression of the common carotid artery and the internal jugular and innominate veins. Pressure upon the phrenic and vagus nerves is also of importance. The movements of the arm and the neck are restricted, the head is usually inclined to the injured side, and the place of insertion of the sterno-mastoid muscle is more or less obliterated. The shoulder is displaced forward and the acromial end of the clavicle is unduly prominent.

Retrosternal dislocation of the clavicle arises usually from a forcible movement of the shoulder forward and inward, less often from direct violence applied to the head of the clavicle from in front.

Reduction of a retrosternal dislocation of the clavicle is accomplished

by drawing both shoulders backward and bracing the knee firmly between the two scapulæ, or by laying a pad in the axilla and adducting the elbow against the chest. If reduction does not succeed in this way, it has been recommended that the dislocated bone be drawn forward with blunt hooks, in order to remove the dangerous pressure upon the large vessels and nerves and upon the trachea and the œsophagus. The retention of the end of the bone is difficult in this dislocation also. (See also Bandages for Fractures of the Clavicle, § 265, pages 494–497.) In case of severe symptoms of pressure upon the vessels and nerves, dyspnoea, and dysphagia, resection of the dislocated sternal end may come into consideration.

C. Dislocation of Both Ends of the Clavicle.—Besides cases of their own, Lucas collected from literature ten and Kaufmann seven cases of dislocation of the clavicle at its two ends. They were mostly cases in which the shoulders were forcibly pressed together and the body was rotated from behind forward around one firmly fixed shoulder. The later functional result was good. One end at least always united in its normal position, while the other remained dislocated without occasioning any disability.

§ 267. **Fractures of the Scapula.**—Fractures of the scapula are rare, because the bone is very movable, is well protected by muscles, and lies upon the elastic ribs, which are more likely to break. The following are the principal forms of fracture that are distinguished: 1. Fractures of the body of the scapula. 2. Fractures of the glenoid cavity and the neck of the scapula. 3. Fractures of the acromion. 4. Fractures of the coracoid process.

1. **Fractures of the Body of the Scapula** arise almost always from direct violence (blow, thrust, being run over, gunshot injury, etc.), and are therefore combined with corresponding contusion of the soft parts. Transverse or comminuted fractures of the infraspinous fossa are the most frequent, fractures of the supraspinous fossa being less common. Longitudinal fractures through the supraspinous fossa, through the spine, and into the infraspinous fossa, are sometimes observed. Displacements of the fragments by muscular action occur especially in transverse and comminuted fractures—e. g., in transverse fractures of the lower angle, the lower fragment being drawn forward and upward by the serratus magnus and the teres major muscles.

The symptoms of a fracture of the body of the scapula are sometimes very evident, and in other cases they are not very distinct. Localized pain, which may be spontaneous or felt on pressure or active and passive movements of the scapula, is usually well marked, as well as the swelling that quickly follows the injury and the other common symptoms of fracture (deformity, abnormal mobility, and crepitus).

The latter are best verified by grasping the scapula at the acromion and the lower angle and attempting to move it, or by laying the arm of the injured side upon the back of the patient and thereby lifting the scapula from the ribs, or, finally, by moving the humerus and placing the hand upon the scapula.

The prognosis of fractures of the body of the scapula is favourable. Bony union usually follows speedily, often, to be sure, with some displacement, but without functional disturbance. In compound comminuted fractures extensive burrowing of pus between the dorsal and the thoracic muscles may result in case of non-aseptic healing.

The treatment of simple fractures of the body of the scapula consists in the use of a sling and in fixing the arm and the scapula to the chest by means of wadding and gauze bandages which are smeared with a little water-glass or plaster of Paris. If necessary, the fragments are sutured. Gunshot fractures or compound comminuted fractures are treated under antiseptic precautions and in accordance with general rules (see *Principles of Surgery*, page 597 ff.). Corresponding defects sometimes remain in consequence of the extraction of splinters or of necrosis. Careful attention must be paid to any abscesses that may form.

2. Fractures of the Neck of the Scapula.—Three forms of this fracture have been distinguished: 1. Fracture of the glenoid fossa (Fig. 629). 2. Fracture of the so-called anatomical neck—that is, the constricted portion just behind the glenoid fossa. 3. Fracture of the surgical neck, which extends from the origin of the body of the scapula and the superior scapular notch to the lower angle of the glenoid fossa or below the infraglenoid tubercle (*a* and *b*, Fig. 629).

Fracture of the glenoid fossa is most frequently observed in connection with dislocations from a fall or a blow upon the shoulder. Crepitus is obtained by raising the arm, rotating the head of the humerus, and pressing the latter against the articular surface. Other symptoms, aside from an effusion of blood into the joint, are absent, especially if the fragments are not displaced. If, however, an oblique fracture through the glenoid fossa and the anatomical neck, such as the one represented in Fig. 629, is present, the fragment that is broken off is usually displaced downward, and the deformity is similar to that in axillary dislocation of the humerus.



FIG. 629.—Fracture of the glenoid cavity of the scapula: *a* and *b*, lines of fracture through the surgical neck of the scapula; *a*, without detachment of the coracoid process, and *b*, with detachment of the same (diagrammatic).

Isolated fractures of the compact anatomical neck directly behind the glenoid fossa are very rare.

The most common fracture in the region of the glenoid fossa of the scapula is that through the surgical neck, in which the line of fracture, corresponding to the line *b* (Fig. 629), runs from the superior scapular notch obliquely downward to a point below the glenoid cavity, so that the coracoid process and the articular process with the glenoid fossa are separated from the rest of the bone. Much less frequently the line of fracture corresponds about to the line *a* (Fig. 629), so that the coracoid process is not broken off. The symptoms of fracture of the surgical neck of the scapula are similar to those attending dislocation of the humerus into the axilla, as the fragment is displaced downward with the humerus. The shoulder is therefore flattened, the acromion process is more prominent, and the axis of the upper arm deviates distinctly toward the axilla, where the fragment can be felt. As opposed to dislocation, the shoulder joint is capable of active and passive movement, although this is attended with great pain. Crepitus is most easily obtained by pressing the humerus against the glenoid fossa and rotating the same, also by moving the coracoid process, in case the latter is broken off. It is characteristic of fracture, as opposed to axillary dislocation of the humerus, that the deformity can easily be corrected, as a rule, by pushing the arm directly upward, and by pressure upon the fragment in the axilla, but reappears just as easily when the arm is allowed to hang downward.

Treatment.—In fractures of the glenoid fossa without displacement a sling and fixation of the arm, which is flexed at a right angle at the elbow, are sufficient. A wad of cotton is placed in the axilla. Oblique fractures of the glenoid fossa with displacement of the fragment downward, as in Fig. 629, as well as fractures of the anatomical and the surgical neck of the scapula, are treated in the same way. After reduction of the displaced fragment, preferably under an anæsthetic, by pressure from within the axilla and by pushing the arm upward, one inserts a large wad of cotton, or, better, a wedge-shaped pad, into the axilla, places the arm, which is flexed at a right angle at the elbow, in a sling, and secures it by turns of a bandage about the thorax and the shoulder. These turns are smeared with water-glass or plaster of Paris, or a typical plaster-of-Paris splint is applied about the shoulder and the thorax. One may also fasten the arm to the thorax, as represented in Fig. 618 or according to Fig. 619, page 494 (after Velpeau). The bandages represented on page 512 for fracture of the neck of the humerus are also very practical, as are, finally, splints of gutta-percha, which are properly moulded in hot water so as to fit the

shoulder. Extension appliances have also been recommended, the arm being drawn obliquely upward, outward, and somewhat backward, and the patient kept in bed. Bony union of the fracture usually ensues in from six to eight weeks without functional disturbance. Elevation and rotation of the arm sometimes continue to be more or less impeded. Pseudarthrosis is rare.

3. **Fracture of the Acromion Process**, in consequence of the exposed position of the latter, is the most common of the fractures of the scapula. It is due usually to direct violence (fall, blow), less often to a fall upon the elbow, and only exceptionally to muscular action in connection with forcible elevation of the arm. The line of fracture runs obliquely or transversely through the tip or near the base. The smaller fragment is displaced, especially in case of extensive laceration of the periosteum and the surrounding soft parts, usually in a downward direction, in consequence of the action of the deltoid muscle and the weight of the arm. The displacement is usually slight, however, because the trapezius acts in the opposite direction. The fracture is characterized by pain at the site of the injury, especially on palpation and raising the arm, by abnormal mobility, and by crepitus on moving the acromion process and pushing the arm upward and downward. Bony union usually ensues in from three to four weeks. Pseudarthrosis sometimes occurs. If the union of the fragments is very loose, the arm can usually be raised only to the horizontal.

The treatment of fractures of the acromion process consists in the use of a sling and in securing the arm to the chest over a soft pad. In case of decided displacement, suture of the fragments is to be recommended.

4. **Fractures of the Coracoid Process**.—These fractures seldom occur alone, but are usually combined with fracture of another portion of the scapula. The fracture usually arises from direct violence, from impact of the head of the humerus in dislocations of the same, and sometimes from muscular action. If the coracoid process is completely broken off, which generally occurs at the base, it is drawn downward and inward by the biceps, the coracobrachialis, and the pectoralis minor muscles in case the coraco-clavicular ligament is ruptured at the same time. If the latter remains intact, the displacement is slight. The fracture not infrequently unites with the formation of a pseudarthrosis, but without much disability of the arm.

The treatment consists in the use of a sling and in securing the forearm, which is adducted and flexed at an acute angle, to the thorax, in order to relax as much as possible the above-mentioned muscles.

§ 268. **Fractures of the Upper End of the Humerus**.—The following fractures occur at the upper extremity of the humerus: 1. Fracture of the head. 2. Fracture of the anatomical neck. 3. Separation of the

epiphysis. 4. Fracture of the surgical neck. 5. Fracture of the tuberosities. These individual fractures are combined in the greatest variety of ways.

1. **Fracture of the Head of the Humerus.**—Isolated fractures of the head of the humerus are very rare. The mildest degree of these fractures occurs in the form of crushing and fissuring of the cartilage—e. g., in dislocations. The isolated fractures proper of the head of the humerus arise most commonly from gunshot injuries, with more or less shattering of the head, also from a fall upon the shoulder or elbow, especially in old people. Such isolated fractures of the head of the humerus are characterized by an intra-articular effusion of blood which conforms exactly to the configuration of the joint. There is usually no other deformity, as the lower fragment is held firmly by the capsule. Crepitus can generally be detected. The latter can be made out by rotating the humerus and pressing the head against the glenoid fossa, and by palpating the head from within the axilla with the arm elevated. In other respects the symptoms are essentially the same as those of fracture of the anatomical neck, and the treatment also conforms to the same principles.

2. **Fractures of the Anatomical Neck of the Humerus.**—The anatomical neck of the humerus is intracapsular and lies close to the insertion of the capsule, immediately behind the edge of the articular cartilage. The very rare fractures of the anatomical neck (Fig. 630) are observed especially among older people, and result chiefly from direct violence (fall or blow upon the shoulder). They frequently extend into the surgical neck, which is outside the joint, so that we then have a fracture which is in part extracapsular and in part intracapsular. In such cases the tuberosities also are sometimes broken off. In fractures of the anatomical neck alone there is sometimes no appreciable displacement, because the lower fragment is held fast by the capsule or because the fragments are impacted. In other cases, however,



FIG. 630.—Fracture of the anatomical neck of the humerus: *a*, capsule reflected.

the lower fragment is drawn upward and inward by the deltoid and pectoralis major muscles. The upper fragment may also be displaced—e. g., downward—or it may rotate so that its articular surface is directed more downward or completely outward. If the capsule is ruptured, the head of the humerus may enter the axilla. In impacted fractures the tuberosities may be broken off by the head which is driven in between them.

The symptoms of a fracture of the anatomical neck are not always distinct. There is in every case a marked swelling of the shoulder. In impacted fractures, particularly, the deformity, aside from an intra-articular effusion of blood, is slight, and the injury may resemble a severe contusion of the shoulder. There is only slight shortening of the arm and flattening of the shoulder. Crepitus and abnormal mobility are absent in impacted fractures, or are conditioned upon coexisting fracture of the tuberosities. The examination of impacted fractures should be made very cautiously, in order that the impaction may not be disturbed. In non-impacted fractures the usual symptoms of fracture (crepitus, abnormal mobility, and possible deformity) are to be determined by abducting the arm from the thorax, elevating it somewhat, and then pressing it upward while the shoulder is fixed, or by grasping the head of the humerus in the axilla, or, finally, by pressing the articular end of the humerus under the acromion downward and backward. When the arm is rotated the broken-off head does not move with it.

Union takes place most readily in impacted fractures. In case of an ordinary intracapsular fracture without impaction, one would naturally expect that no union would take place between the separated and no longer directly nourished head and the lower fragment, and that the head would undergo necrosis. Bony and less often fibrous union usually results, however, after complete separation of the head, even when the latter has been completely rotated on its axis (Smith, Hamilton), because, as a rule, remnants of the capsule and bridges of periosteum remain attached to the head, and provide for its nutrition. Necrosis of the head is especially to be feared when the capsule and the periosteum are completely torn away, and particularly when the branch of the anterior circumflex artery, which supplies the capsule, is wounded (Hoffa). The lower fragment sometimes forms for itself a sort of joint cavity in the upper fragment, much as in intracapsular fractures of the neck of the femur, so that the two fragments are not directly connected. Functional disturbances of the shoulder joint are observed, particularly after compound fractures with subsequent inflammation of the joint, from over-production of callus, from cicatricial contraction of the capsule, from ankylosis, etc.

Treatment of Fractures of the Anatomical Neck.—Impaction of the fragments, if present, should not be disturbed. A simple sling is applied, and the arm bound lightly to the thorax. In non-impacted fractures the attempt should be made to overcome any existing displacement of the upper fragment, preferably with the patient under an anæsthetic. A wedge-shaped pad may then be laid into the axilla and

the arm secured by a sling, and a plaster-of-Paris splint applied about the thorax and the sound shoulder (Fig. 631). The bandages represented on page 512, which are employed for fractures of the surgical neck, may also be used.



FIG. 631.—Plaster splint about the shoulder, chest, and arm for fractures of the upper end of the humerus.

If an appreciable displacement of the upper fragment can not be overcome, or if it recurs easily, the two fragments may be united by means of aseptic nails or long steel pins, which can be screwed in (Helferich), the joint being opened if necessary. In the latter case one may also perform typical resection of the humerus. The latter is especially indicated in compound fractures of the head and the neck of the humerus, with or without comminution—e. g., in gunshot fractures—also in case of pseudarthrosis, in ankylosis, and other functional disturbances of the shoulder joint. For the treatment of compound fractures the reader is referred to Principles of Surgery, pages 597–602; likewise

for the treatment of pseudarthrosis and ankylosis (Principles of Surgery, pages 603 and 698).

3. Separation of the Upper Epiphysis.—The upper epiphyseal line of the humerus, which persists till about the eighteenth or twentieth year, surrounds the articular surface and the two tuberosities. Its course is partly intracapsular and partly extracapsular, running just below the lesser tuberosity, transversely through the greater tuberosity, then in a median direction through the anatomical neck to the lower end of the articular surface and from here obliquely outward below the lesser tuberosity. Separations of the epiphysis occur usually from forcible rotation and extension on the arm of the foetus at delivery; also later, until from the twentieth to the twenty-fifth year, from a fall or blow upon the shoulder. Of all epiphyseal separations those of the upper end of the humerus are the most frequent. Then come those of the lower epiphysis of the radius, and those of the lower epiphysis of the femur. Aside from simple separations of the epiphysis, some are complicated

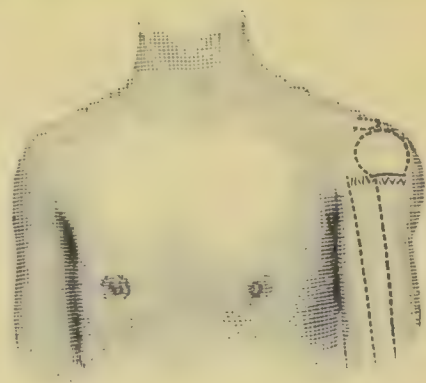


FIG. 632.—Separation of the upper epiphysis of the humerus with displacement of the shaft inward.

by an oblique fracture through the shaft. The displacement is either slight, or the lower fragment may be displaced inward (Fig. 632) or backward. The epiphyseal separations that occur at birth are sometimes, to the misfortune of the children, not recognised sufficiently early. The symptoms are chiefly swelling and pain in the region of the joint. When the humerus is rotated the head does not move with it. One can sometimes distinctly feel that the lower fragment is displaced in an inward or backward direction, and the shoulder is then correspondingly broadened. In contradistinction to dislocations, the deformity can, as a rule, easily be overcome by extension, but recurs immediately when the traction ceases. The active function of the arm is interfered with, while passive movements, on the contrary, are easy, but attended with pain. A characteristic soft cartilaginous crepitus is felt thereby which is not so hard as bony crepitus. Bony union follows, as a rule, but permanent disturbances of growth not infrequently result, with corresponding weakness of the arm, in consequence of premature ossification of the epiphyseal line (Fig. 633). The shortening of the upper arm which thus arises varies in amount. It may be as much as from three to six centimetres. Appreciable shortening may be absent, especially when the epiphyseal cartilage is preserved on one or the other fragment.

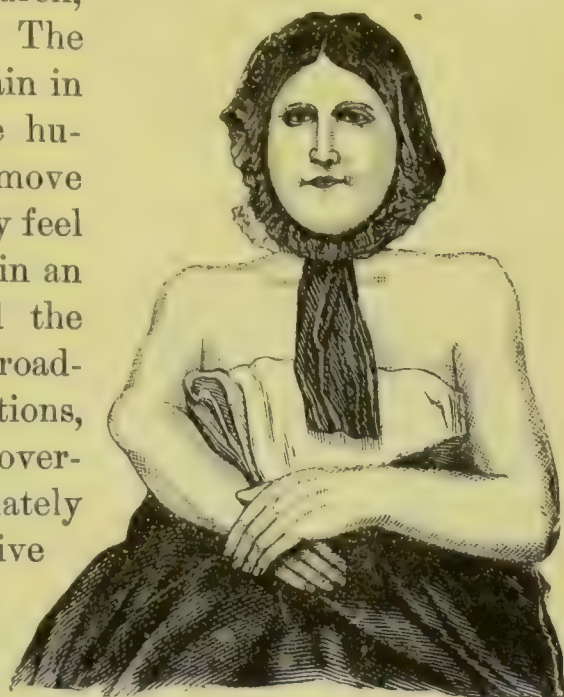


FIG. 633.—Disturbed growth of the right humerus probably in consequence of traumatic separation of the upper epiphysis during the patient's youth (Bryant).

The treatment of separations of the epiphysis conforms to essentially the same rules as that of fractures of the anatomical and the surgical neck (see pages 507 and 512).

4. Fractures of the Tuberosities.—The fractures in the vicinity of the tuberosities are sometimes transverse, longitudinal, or oblique fractures of the upper end of the humerus, sometimes isolated fractures through the greater or lesser tuberosity.

Transverse fracture through the tuberosities presents essentially the same symptoms as fracture of the anatomical neck. The line of fracture runs between the epiphyseal line and the anatomical neck. Its cause is the same as that of fracture of the anatomical neck.

The oblique and longitudinal fractures through the tuberosities or through the upper end of the humerus are of special interest. In

this category belong the fractures that run obliquely or longitudinally through the greater or lesser tuberosity, and also those in which not only the greater or lesser tuberosity is divided, but in which the line of fracture extends farther in a longitudinal or oblique direction through the head of the humerus, and which are therefore more accurately designated as oblique or longitudinal fractures of the head of the humerus. In these fractures the greater tuberosity with one portion of the head may be displaced upward and outward, while the other fragment with the lesser tuberosity may be displaced inward and upward. In such cases the shoulder is strikingly broadened, and a distinct depression is usually felt between the two fragments under the acromion and the coracoid process. The tendon of the biceps may be caught between the two fragments of the head (Ogston). Crepitus is elicited by fixing the two tuberosities and rotating the arm. These fractures arise usually from the action of direct violence upon the anterior aspect of the shoulder joint or the upper end of the humerus.

Fractures of the greater tuberosity alone, in consequence of the action of direct violence, or from violent contraction of the external rotators (particularly the supraspinatus and infraspinatus muscles), e. g., in throwing, are very rare. Avulsion of the greater tuberosity in connection with dislocations and fractures of the anatomical neck are more common. If the greater tuberosity is completely separated at its base, it is usually drawn outward, backward, and upward by the external rotators, whereas the upper end of the humerus follows the traction of the antagonistic muscles, especially the subscapularis, the teres major, and the pectoralis major, and hence is adducted just as in dislocation.

Fracture of the lesser tuberosity alone is extremely rare. It occurs most frequently from the action of the subscapularis muscle in dislocation of the humerus. The fragment of bone that is broken off and drawn inward by the subscapularis muscle can be felt in the region of the lesser tuberosity. The function of the arm, especially its rotation inward, is disturbed. The biceps tendon is not infrequently ruptured in addition to the capsule.

The prognosis of fractures of the tuberosities is not very favourable. Mal-union of the fracture not infrequently follows, with decided displacement of the fragments.

In treating fractures of the tuberosities the attempt should be made to overcome the existing displacement. One may, in suitable cases, hold the fragments in position by sutures, steel pins, or nails, under antiseptic precautions. The same splints are to be recommended as for fractures of the anatomical and the surgical neck (see pages 507 and 512).

5. Fractures of the Surgical Neck of the Humerus.—By fracture of the surgical neck is understood an extracapsular fracture of the shaft of the humerus between the tuberosities and the insertions of the latis-

simus dorsi and the pectoralis major muscles. The fracture is sometimes, however, partially intracapsular also, inasmuch as the line of fracture—e. g., on the inner side of the humerus—runs inside the capsule. The fracture usually arises from direct violence—e. g., from a gunshot injury, from a blow or a fall upon the shoulder, less often indirectly from a fall upon the hand or the elbow. In exceptional cases the surgical neck is broken by violent muscular action—such as throwing a stone or a ball or striking with a whip. The fracture is usually transverse (Fig. 634), less often oblique, and the patients are chiefly



FIG. 634.—Transverse fracture of the surgical neck of the humerus.

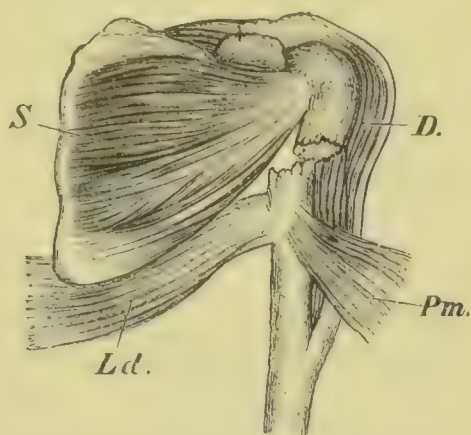


FIG. 635.—Fracture of the surgical neck of the humerus: *D*, deltoid; *Pm*, pectoralis major; *Ld*, latissimus dorsi; *S*, subscapularis.

older persons in whom the cortical substance is atrophic. Impacted fractures are not infrequent. If there is no impaction, the displacement is, as a rule, typical (Fig. 635). The upper fragment is drawn somewhat outward by the external rotators (the supraspinatus, the infraspinatus, and the teres minor muscles), but the subscapularis muscle works against those that have been named. The lower fragment is drawn somewhat upward by the deltoid muscle and inward by the pectoralis major, the latissimus dorsi, and the teres major. The character of the displacement depends essentially upon the direction in which the violence acts, and it is most pronounced in oblique fractures. In the latter the skin and the muscles are often punctured. The line of fracture, as has been said, sometimes runs into the joint. Fissures running into the joint occur usually in comminuted fractures.

The symptoms of fracture of the surgical neck are usually clearly marked in non-impacted fractures. The deformity in typical cases is characterized by flattening of the shoulder, by a depression or angle in the upper arm below the shoulder which can be seen and felt, and not infrequently by a noticeable shortening of the humerus. Abnormal mobility and crepitus are easily determined, in fractures that are not impacted, by rotating the arm, and one then finds that the head does

not follow these movements of the shaft. A false point of motion is noticeable at the site of the fracture by abduction of the arm from the thorax. The lower fragment is distinctly felt in the axilla, especially when the arm is rotated. The axis of the humerus deviates inward toward the axilla, as in axillary and subcoracoid dislocation of the humerus; but in the latter the glenoid fossa beneath the acromion is empty, the arm is fixed, the elbow can not be placed against the thorax, and the deformity can be overcome only by certain methods of reduction. In fracture of the surgical neck of the humerus, on the contrary, the passive mobility of the arm is considerable, and the deformity can be easily overcome by extension, but returns immediately upon cessation of the traction. The pain is severe, especially when the lower fragment presses on the brachial plexus. Gangrene of the arm may arise from compression of the large vessels in the axilla by the upper or lower displaced fragment, so that amputation at the shoulder becomes necessary (Angerer).

The symptoms are, of course, by no means so distinct in impacted fractures of the surgical neck. Indeed, the existence of a fracture may here be only a matter of conjecture, when in older people after a fall upon the shoulder there is a large effusion of blood, the movements of the shoulder are disturbed, and no dislocation is demonstrable. In all cases where the diagnosis is difficult on account of a large effusion of blood, the latter should, if possible, be removed by massage. All doubtful cases should be treated as though a fracture existed.



FIG. 636.—Splint for fractures of the surgical neck of the humerus. The arm is finally secured by bandages passing around the chest and both shoulders.

The prognosis of fracture of the surgical neck of the humerus is not unfavourable. Bony union usually follows in from four and a half to six weeks, without functional disturbance of the shoulder joint. Such disturbance is especially to be feared after compound fractures with suppuration of the joint, in consequence of mal-union of the fracture, and from a hypertrophic callus which extends into the joint. Paralysis of the nerves of the arm sometimes arises from pressure of a badly united fracture and of a hypertrophic callus—e. g., paralysis of the circumflex, musculospiral, ulnar, and median nerves.

Treatment of Fractures of the Surgical Neck.—In treating a fracture of the surgical neck of the humerus one will first overcome any displacement, then insert a pad into the axilla, secure the arm, which is bent at a right angle at the elbow, in a sling, and finally fasten it to the

chest by means of wadding and plaster-of-Paris bandages around the thorax and the shoulder (Fig. 631, page 508). The dressings represented in Figs. 618, 619, and 622, pages 494, 495, with plaster of Paris or water-glass, are also serviceable, as well as splints of gutta-percha



FIG. 637.—Splint of hemp and plaster of Paris for fractures of the upper end of the humerus (Schönborn and Beely).

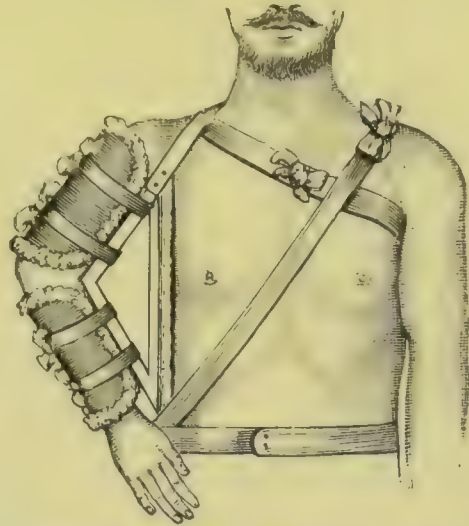


FIG. 638.—Middeldorpf's triangle for fractures of the upper end of the humerus.

or pasteboard for the shoulder and the arm, combined with a pad for the axilla (Fig. 636), or splints of hemp and plaster of Paris, after Schönborn and Beely (Fig. 637), or, finally, the wooden triangle, after Middeldorpf, which is easily made (Fig. 638).

Compound fractures are treated according to general rules. The fragments should be united, if necessary, by suture or by the use of nails or steel pins (see Principles of Surgery, page 597 ff.). In case of extensive comminution of the bone, resection is indicated. The greater the injury to the soft parts the greater may be the necessity for immediate amputation or disarticulation. If the soft parts are punctured by the fragments they should be freed, if necessary, by an incision. Active and passive movements of the joint should follow union of the fracture, in order that the shoulder may not become stiff. The muscles of the shoulder and the entire arm are treated by massage and electricity. Mal-union of a fracture causing pressure paralysis is treated by operation. The site of the fracture is exposed, and one then proceeds according to the conditions found.

§ 269. **Dislocations of the Shoulder.**—These dislocations are very frequent in consequence of the great mobility and the exposed position of the joint—as frequent, in fact, as all other dislocations taken together. They are most common among men of middle and advanced age, and result from the greatest variety of traumatisms. In rare cases dislocation has been seen to occur during sleep, being caused by epileptic convulsions (Laren, Richter, the author). The great frequency of dislocations of the shoulder is explained by

the anatomical structure of the joint. The round head of the humerus lies in a very shallow glenoid cavity, and the capsule is rather lax and thin in comparison with other articulations. The capsule has the greatest resistance at the points where it is strengthened by the insertions of the supraspinatus, the infraspinatus, and the subscapularis muscles and by the broad coracohumeral ligament. The relatively weakest part of the capsule lies between the insertions of the teres major and subscapularis muscles. The capsule is here slightly strengthened by tendinous fibres arising from the teres major and the long head of the triceps and from the axilla. The rupture in the capsule in connection with dislocations of the shoulder joint is most frequently found in the lower, weakest part, which has just been mentioned. In very rare cases of complete dislocation the capsule remains untorn (Eve, Claude Evill). The occurrence of an upward dislocation of the shoulder joint is difficult on account of the acromion, the coracoid process, and the coraco-acromial ligament; it is scarcely possible without fracture of the bones named. Two principal varieties of dislocation occur, therefore, at the shoulder joint—viz., forward and backward dislocations. In addition to these two principal forms, a dislocation directly downward below the glenoid cavity is also observed in rare cases. The tear in the capsule, as has been said, is usually found at its lower part, a little farther forward or backward, and the final location of the head depends upon the nature and direction of the force that is exerted and upon any secondary movement of the same. The exit of the head directly downward is rendered difficult by the stout tendon of the long head of the triceps. The head, therefore, seldom remains directly beneath the glenoid cavity, but moves either forward or backward. We thus distinguish the following principal forms of dislocation at the shoulder joint:

I. Forward Dislocation (Preglenoidal Dislocation).—This is the most frequent form of dislocation, and is subdivided as follows:

1. Axillary dislocation.
2. Subcoracoid dislocation.
3. Subclavicular or intracoracoid dislocation.

II. Downward or Subglenoid Dislocation.—This rare dislocation is to be regarded as a variety of the axillary dislocation. Axillary dislocation is designated by many authors as subglenoid dislocation.

III. Backward Dislocation.—This takes the form of—

1. Subacromial dislocation.
2. Infraspinous or subspinous dislocation.

In all dislocations of the shoulder joint the following main symptoms are present: 1. Pain at the site of the injury. 2. Flattening of the shoulder with a depression beneath the acromion, where otherwise the head or the neck of the humerus is to be felt. 3. Undue prominence of the acromion. 4. Stiffness or diminished mobility of the shoulder joint and fixation of the upper arm. 5. Abnormal location of the head of the humerus, with a corresponding change in the axis of the arm. 6. The elbow can not be brought in contact with the chest. As regards the differential diagnosis between fracture and dislocation, one must hold fast to the fact that the characteristic deformity conditioned upon dislocation can only be overcome by certain definite methods of reduction, and that, immediately upon reposition of the head, all objective

and subjective symptoms disappear. A fracture behaves differently. The deformity is easily overcome, as a rule, by traction upon the humerus, but as soon as the extension ceases the deformity immediately returns.

A. Forward Dislocation of the Shoulder.—This most frequent form of dislocation of the shoulder arises sometimes from direct and sometimes from indirect violence—e. g., from a fall or blow upon the shoulder, often from forcible abduction of the arm, from a fall upon the elbow or the hand, from violent muscular exertion in throwing, in convulsions, etc. By the action of all these forms of violence, especially forced abduction, the head is pressed against the lower anterior portion of the capsule, which is the weakest, while the tuberosities impinge against the acromion. If the violence continues to act, the capsule is ruptured in its lower anterior portion between the subscapularis muscle and the long head of the triceps, and the head enters the axilla (axillary or subglenoid dislocation). The head remains either at the lower and anterior border of the glenoid cavity, or directly beneath the latter (subglenoid dislocation), or, what is much more frequent, it is forced farther upward by a secondary movement due to the elastic tension of the soft parts. It comes to lie most commonly beneath the coracoid process (subcoracoid dislocation) or to the inner side of the latter, or under the clavicle (intracoracoid or subclavicular dislocation). The size of the rent in the capsule is very variable. The larger it is the farther the head is forced upward by the elastic soft parts that are on the stretch. It is held here by the bony prominences of the coracoid process and the clavicle, and by the tense untorn portion of the capsule.

Forward dislocations of the shoulder joint are often associated with injuries of the bones and the soft parts. As regards injuries of the humerus and the glenoid cavity, fractures of the surgical neck are sometimes observed as well as breaking off of the greater tuberosity by the acromion or avulsion of the same by the external rotators, especially by the supraspinatus and infraspinatus muscles, also avulsion of the lesser tuberosity by the strong tendon of the subscapularis muscle, crushing of the head, and, finally, comminuted fractures of the glenoid cavity or rupture of the glenoid ligament. Of the muscles and tendons, the external rotators (supraspinatus, infraspinatus, and teres minor), as well as the tendon of the biceps muscle, are especially endangered. They may be greatly stretched, torn, or completely ruptured. The short head of the biceps, the coraco-brachialis, and the deltoid are also stretched a good deal, and the subscapularis is, as a rule, more or less contused. The head sometimes forces its way through the deltoid and the fibres of the subscapularis (subscapular dislocation). Finally, the vessels and nerves of the axilla may be severely stretched or lacer-

ated. Ruptures of the large vessels and nerves are very rare. The circumflex nerve, which supplies the posterior portion of the deltoid muscle, is most endangered. Compression of the nerves and vessels of the axilla occurs, especially when the head remains in the axilla in the vicinity of the lower border of the glenoid cavity. There is always more or less bloody infiltration about the joint. In rare cases the skin and the coverings of soft parts are so torn that the dislocated head is exposed in the wound (compound dislocation).

The separate varieties of forward dislocation of the shoulder are the following:

1. *Subcoracoid Dislocation*.—Dislocation of the humerus beneath the coracoid process (Figs. 639 and 640) is the most common dislocation of the shoulder joint. The head usually rests beneath the coracoid process in such a way that the anatomical neck lies upon the anterior border of the glenoid fossa and above the tendon of the subscapularis muscle, which is frequently ruptured. The head sometimes passes through the fibres of the subscapularis, so that they encompass the neck of the humerus like a sling, and may prove an obstacle to reduction.

The most important symptoms of subcoracoid dislocation of the shoulder are the following (Fig. 640):

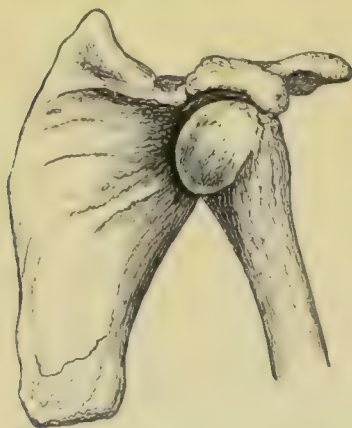


FIG. 639.—Subcoracoid dislocation of the humerus.

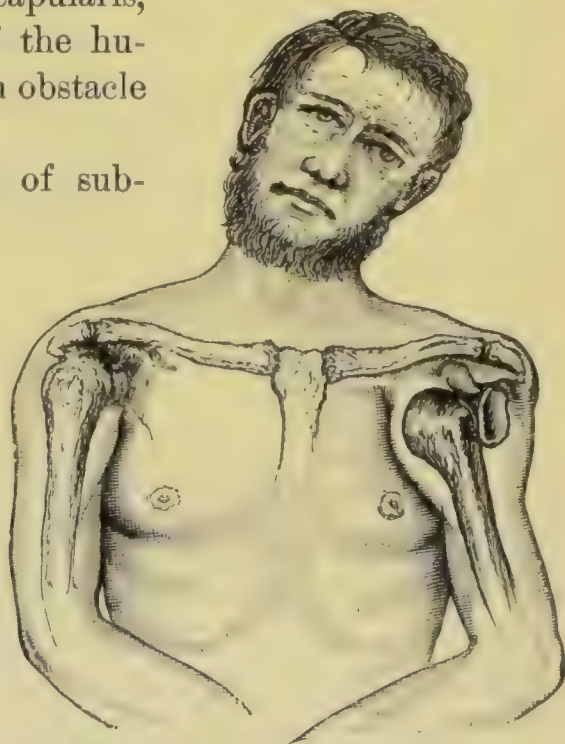


FIG. 640.—Subcoracoid dislocation of the humerus.

The acromion is prominent, and beneath it a distinct depression can be felt in place of the upper end of the humerus. The dislocated head can be felt below the coracoid process, and forms here a visible swelling. The axis of the humerus is not directed toward the glenoid fossa, but points farther inward toward Mohrenheim's space. The arm seems somewhat elongated, and the elbow is abducted and can not be brought in contact with the chest. The movements of the shoulder joint are

almost entirely suspended, the dislocated head is fixed, and when passive movements are attempted an elastic resistance is felt. The deformity can not be overcome by simple extension, as, for example, in fractures,

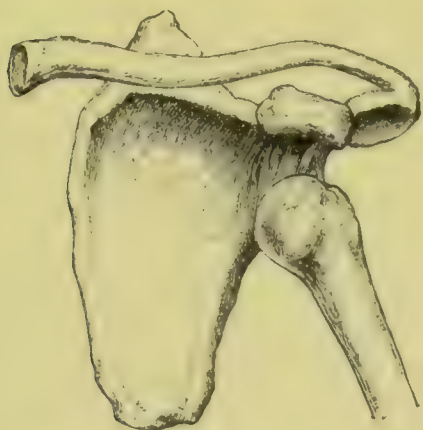


FIG. 641.—Axillary dislocation of the humerus.

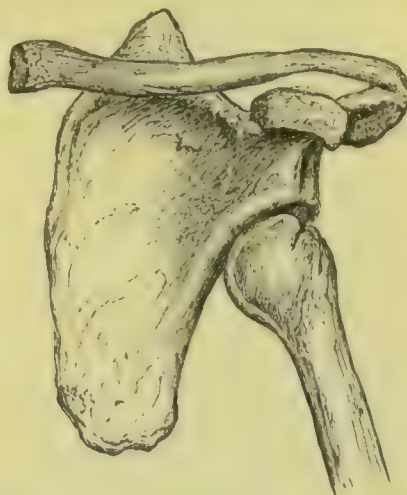


FIG. 642.—Subglenoid dislocation of the humerus.

but only by definite methods of reduction. The head of the patient is usually inclined toward the injured side.

2. *Axillary Dislocation*.—In axillary dislocation (Fig. 641) the head passes forward and downward into the axilla, between the subscapularis, the long head of the triceps, and the teres major and minor. In very rare cases the head comes to lie farther down against the infraglenoid tubercle, and it may then be drawn still farther downward by the latissimus dorsi and the pectoralis major muscles (subglenoid dislocation, see Fig. 642).

The symptoms of axillary dislocation are essentially the same as those of subcoracoid dislocation, except that the head is lower down and can be felt in the axilla. In this dislocation also the acromion is prominent, and a gap or depression can be felt beneath it. The deltoid muscle is noticeably tense, and the arm seems more elongated than in subcoracoid dislocation. The arm is strongly abducted, the elbow can not be laid against the chest, etc. The head



FIG. 643.—Luxatio erecta.

sometimes lies still lower, forming really a downward dislocation of the humerus (subglenoid dislocation). In such cases the arm may remain in the position taken at the moment the dislocation occurs, so that the patient comes to the surgeon with the arm elevated and lying upon the

head (*luxatio erecta*, Fig. 643). Since in this subglenoid dislocation the head is always displaced forward at the same time, this is to be



FIG. 644.—Supracoracoid dislocation of the right humerus (W. Busch).

considered as merely a variety of the axillary dislocation—that is, dislocation forward and downward. If in a forward and downward dislocation the head passes through the lower portion of the subscapularis muscle and remains there, the dislocation has also been designated as subscapular dislocation.

3. *Subclavicular (Intracoracoid) Dislocation*.—Dislocation of the head of the humerus beneath the clavicle to the inner side of the coracoid process, therefore called also intracoracoid, is very rare. It is characterized by much laceration of the soft parts, especially of the muscles which have their insertion on the greater and lesser tuberosities (supraspinatus, infraspinatus, teres minor, and subscapularis).

The head may be covered only by skin and fascia (Malgaigne). The dislocated head forms a swelling that can be seen and felt under the clavicle to the inner side of the coracoid process, the arm is strongly abducted and sometimes fixed in a horizontal

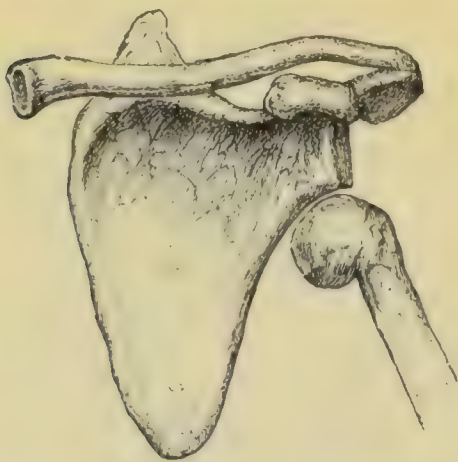


FIG. 645.—Subglenoid dislocation of the humerus.

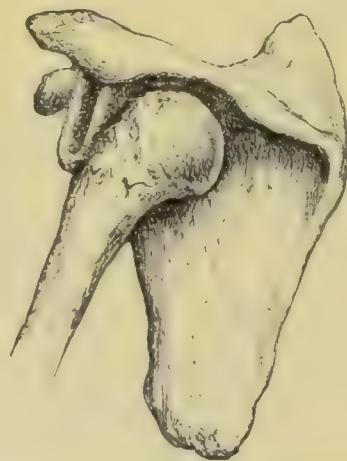


FIG. 646.—Retroglenoid dislocation of the humerus.

position (Bardenheuer), the shoulder is decidedly flattened, and the arm itself is shortened.

4. *Supracoracoid Dislocation*.—This form of dislocation forward and upward (Fig. 644) is very rare, and only possible after fracture of the coracoid process or the acromion. There is, in addition, rupture

of the tendon of the subscapularis muscle, and the anterior portion of the capsule is extensively torn. The head lies in contact with the coraco-acromial ligament between the acromion and the coracoid process, covers the latter, and is adjacent above and on the inner side to the clavicle. The distinct flattening of the shoulder beneath the acromion, which is present in other forward dislocations of the shoulder, is absent here, and the upper arm is abducted and shortened. Crepitus can be made out, and is due to fracture of the coracoid process. Malgaigne and W. Busch in particular have described this supracoracoid dislocation in detail.

B. Downward Dislocation (Subglenoid Dislocation).—The downward dislocations of the shoulder joint are really to be looked upon as dislocations forward and downward, and we have therefore described them in connection with axillary dislocations. It is only in very rare cases that the humerus is dislocated directly downward and remains resting on the infraglenoid tubercle below the glenoid fossa (Fig. 645). The etiology and symptomatology are essentially the same as in axillary dislocations. Sometimes, as has been mentioned, the arm is directed perpendicularly upward (*luxatio erecta*). Not every *luxatio erecta*, however, is to be regarded as a subglenoid dislocation; it is also observed in axillary dislocation (see Fig. 643, page 517), when the head, which is dislocated forward and downward, moves a little farther downward.

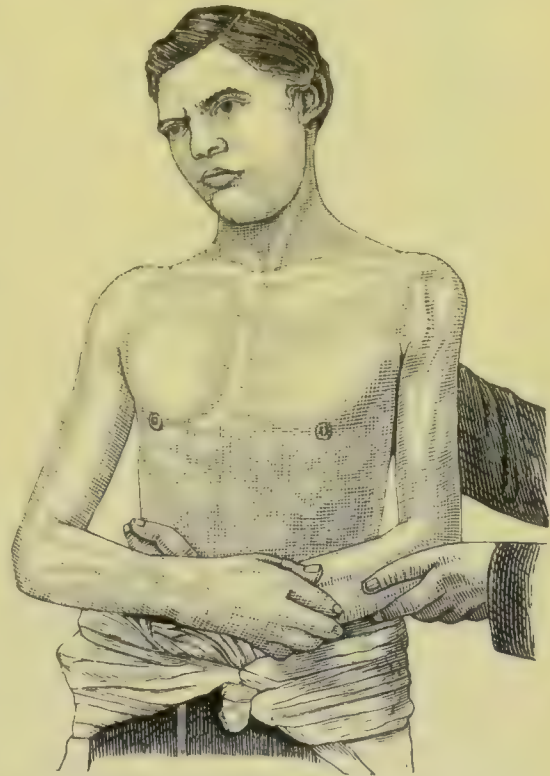


FIG. 647.—Retroglenoid dislocation of the left shoulder (W. Busch).

C. Backward Dislocation (Retroglenoid Dislocation).—Backward dislocations of the shoulder are much less common than forward dislocations. They occur occasionally from a blow or a fall upon the front of the shoulder, from a fall upon the outstretched hand, or from a blow upon the elbow when it is flexed across the chest, or, finally, from violent muscular action—e. g., from forcible inward rotation of the arm. The tear in the capsule is usually posterior. The head rests either upon the neck of the scapula beneath the acromion (subacromial dislocation), or farther back below the spine of the scapula in the infraspinous fossa, between the infraspinatus and teres minor muscles (in-

fraspinous or subspinous dislocation, Fig. 646). The rent is sometimes found in the lower part of the capsule—i. e., a subglenoid dislocation first takes place, and from this, by secondary movement of the dislocated head upward and backward, a dislocation backward beneath the acromion or the spine of the scapula.



FIG. 648.—Retroglenoid dislocation of the left shoulder.

Clinically, backward dislocation of the head of the humerus is characterized by the following symptoms: A distinct depression is seen upon the anterior aspect of the shoulder, in which one feels the empty glenoid cavity; the whole shoulder is, as it were, displaced backward, and the acromion and the coracoid processes are very prominent. A decided bulging is noticeable behind the acromion or still farther back, and the head can be felt here. The axis of the upper arm is directed backward and outward, and the elbow is abducted and rotated a little forward. The arm appears somewhat elongated, especially in subacromial dislocations.

Sometimes, as was mentioned above, dislocations of the shoulder are complicated by fractures. In case of coexisting fracture of the tuberosities, the dislocated head is usually very movable, and the symptoms described on page 509 are present. If a dislocation is associated with fracture of the anatomical or surgical neck of the humerus, the arm is not fixed as in a pure dislocation, but is perfectly movable passively. Crepitus is felt, and the deformity caused by the fracture can be easily overcome by extension.

The diagnosis of dislocations of the shoulder is made from the group of symptoms that have been described, and is, generally speaking, easy. The differential diagnosis between fracture and dislocation has been briefly touched upon. Fracture of the neck of the scapula and that of the anatomical and the surgical necks of the humerus come especially under consideration.

The prognosis of uncomplicated dislocations of the shoulder is, generally speaking, favourable. If reduction is accomplished as soon as possible after the injury, complete return to the normal usually ensues. Chronic arthritis deformans sometimes develops subsequently with functional disability of the shoulder joint. Recurrences of the dislocation are particularly to be feared in case of a large rent in the capsule, especially in backward and subclavicular dislocations, or when the movements of the shoulder joint are resumed too early. So-called habitual dislocations are most common at the shoulder—that is, a dislocation follows from the most trifling injuries or from simple muscular action, so that such persons may dislocate the shoulder joint forty or fifty times. I knew a clergyman who was obliged to give up his profession because dislocation of the shoulder joint usually attended the raising of his arm, and he would not submit to operative treatment. The causes of this habitual dislocation are varied. The size of the rent in the capsule and the tearing away of the supraspinatus and infraspinatus muscles

from the greater tuberosity play an especially important part. If these muscles do not unite again with the humerus, the attachment of the latter to the scapula is defective and the arm sinks downward and inward of its own weight, as well as in consequence of the traction of the adductors and the inward rotators. In consequence of this displacement of the humerus, the form of the latter and of the glenoid cavity are correspondingly changed and the resulting loose joint may be dislocated even without a tear in the capsule (Löbker). Among other causes of habitual dislocations I will mention especially the imperfect healing of the tear in the capsule, in consequence, for example, of too early movement of the shoulder joint, an enlarged communication between the articular cavity and the bursa of the subscapularis muscle (Roser), and, finally, fractures of the humerus and the glenoid cavity.

If the dislocation of the shoulder joint is not reduced, a more or less complete new joint is formed at the new location of the head, with corresponding atrophy of the glenoid cavity. The functional disability of the upper arm is usually marked in such cases, elevation of the arm being particularly interfered with. Tropho-neurotic disturbances or even complete paralysis may ensue from pressure of the head upon the nerves.

The complications that are especially important from a prognostic point of view are extensive lacerations of the soft parts, rupture of the skin (compound dislocations), the rare injuries of the brachial plexus and of the large vessels of the axilla, injury of the circumflex nerve, with paralysis of the deltoid and the teres minor muscles, and simultaneous fracture—e. g., of the tuberosities, the anatomical and the surgical neck of the humerus, the glenoid cavity, or the neck of the scapula. Procharska observed a case in which the head of the humerus entered the thorax between the second and third ribs. The prognosis of paralyses following dislocations of the shoulder is not favourable so far as a complete return to the normal is concerned. A. Wiegand collected fifty-nine cases from the literature of the subject. For the treatment of the complications that have been mentioned, see pages 524, 525, and 530–533.

Treatment of Dislocations of the Shoulder.—The treatment of dislocations of the shoulder consists in the earliest possible reposition of the dislocated head. Reduction may be first tried without an anæsthetic, and if this is not successful, an anæsthetic should be used, in order to overcome the resistance of the contracted muscles and the tense soft parts. In old cases also reduction should be attempted with the patient under an anæsthetic, and in case of failure, one should expose the dislocated head and then proceed according to what is found (see page 525). Reduction is easiest immediately after the injury. It becomes more and more difficult later and may be impossible after a few days, so that one must resort to an operation, as I was recently compelled to do three days after the occurrence of the injury. Reduction is usually attended by a distinct snapping noise, and, as an evidence of its success, the deformity completely disappears and the joint becomes normally movable, both actively and passively.

The most important methods of reduction in uncomplicated dislocations of the humerus forward and downward are the following:

1. **Avicenna's Method.**—The patient sits in a chair while the surgeon stands upon the injured side, grasps the shoulder from above with the left hand, in case of dislocation on the right side, fixes it and presses it downward, and, supporting the humerus with the right forearm, strives to grasp the head as well as possible from within the axilla with the fingers of the right hand and to press it back into the glenoid cavity. This comparatively very simple method, which is employed without the use of an anæsthetic, is very serviceable, especially in axillary and subcoracoid dislocations and also in dislocations which are complicated by fracture of the neck of the humerus.

2. **Extension Methods.**—Among extension methods, the elevation method, after Mothe, is especially to be recommended (Fig. 649). The patient sits in a chair or lies upon a mattress placed on the floor or upon an operating table. The shoulder is fixed from above, the arm is raised into a perpendicular position, and the dislocated head is pressed from below and inward directly into the glenoid cavity. If there is no assistance at hand, one can fix the shoulder from above with the



FIG. 649.—Mothe's elevation method for the reduction of dislocations of the shoulder.

foot, while the patient is lying down, and then draw the arm backward and upward. G. Simon's pendulum method is also very good—that is, the patient is lifted up by traction on the forearm, while he is lying on the floor or on a mattress, on the sound side, so that the body can be swung to and fro.

Extension can be combined with lever action in the following manner: While the patient is lying down, the dislocated arm is drawn downward and outward and the foot or the fist is pressed into the axilla. Veit Macleod recommends the following method: With the patient in a horizontal position, the dislocated arm is abducted at right angles, and while an assistant presses his heel into the axilla, slight traction is sufficient to effect reduction.

Lever action can also be utilized by Astley Cooper's method. The patient sits on a chair behind which the surgeon stands and, placing his foot upon the chair, presses his bent knee into the axilla. The acromion is pressed down with one hand and the humerus is pulled

downward and inward with the other. If the head is near the glenoid cavity, it is forced into the latter by the knee, which is pressed farther into the axilla by raising the foot upon the toes.

3. Rotation Methods.—Rotation methods have been recommended particularly by Schinzinger and Kocher. In Schinzinger's method the

surgeon grasps the dislocated arm, as shown in Fig. 650, while the patient is sitting or lying down, adducts and rotates it outward until the inner side of the upper arm is directed forward and the greater tuberosity impinges upon the posterior edge of the glenoid cavity.

The arm is then raised and quickly rotated inward. Kocher employs the rotation method as follows in three acts:

1. As in Schinzinger's method, the arm, which is slightly abducted, is first pressed closely against the side. 2. The arm, flexed at right angles at the elbow, is

now rotated, as in Schinzinger's method, in an outward direction, so that the forearm is turned as far as possible away from the trunk. At the same time the movement of the head of the humerus in an out-

ward direction is facilitated by traction by means of a compress under the arm. Downward traction may also be employed. 3. The arm is raised to the horizontal (Fig. 651), or as high as possible, while in the externally rotated position, in order to relax the coraco-humeral ligament, and is then gradually rotated inward, whereby the head slips into the joint. The rotation methods allow the employment of a great deal of force, and they are therefore always to be executed with special care, particularly in old dislocations, as otherwise fractures or injuries of the vessels and the nerves may easily occur.



FIG. 651. — Kocher's method of reduction.

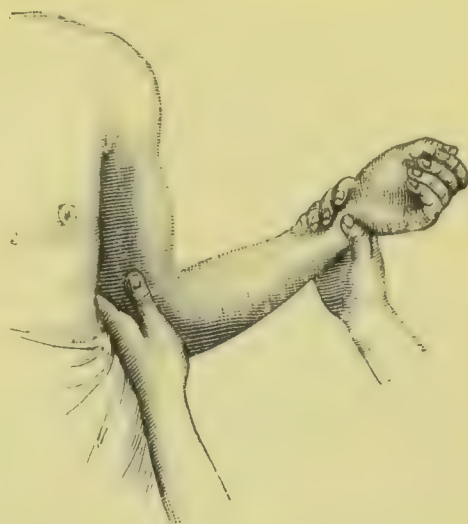


FIG. 650. — Schinzinger's method of reduction.

All the methods of reduction that have been mentioned are especially adapted for dislocations forward and downward, particularly for the two most frequent forms, the subcoracoid and the axillary dislocations. Mothe's elevation method, G. Simon's pendulum method, and the rotation methods of Schinzinger and Kocher are no doubt the ones most commonly employed.

The rare backward dislocations of the humerus are best reduced in the following manner: The arm is raised to a right angle or the hori-

zontal, extended, rotated, and then adducted, while at the same time the head is forced into the glenoid cavity by direct pressure from behind. If this is not successful, reduction is sometimes accomplished very easily by strong abduction of the arm with subsequent rotation inward, or by elevation of the arm and pressure of the head into the cavity.

The after-treatment of dislocations of the shoulder joint following successful reduction consists in immobilizing the arm by means of a sling and a few turns of a bandage around the arm and the thorax, which may be smeared with a little water-glass. Bodice-like jackets of some light material which can be laced are very serviceable for fixing the arm to the thorax. After three or four weeks and sometimes earlier, but at all events not later, use is made of massage, of active and passive movements, and electricity. Extreme movements of the joint are, however, still to be avoided for some weeks as far as possible, because the healing of the rent in the capsule and of the torn accessory ligaments may not be complete, or the cicatrices may become stretched, so that a recurrence takes place.

In case of fresh dislocations which can not be reduced, aseptic arthrotomy should be undertaken—that is, the dislocated bone should be exposed by an incision and the head brought back into the cavity. Resection of the head will sometimes prove necessary. Operative interference, however, is but seldom indicated in fresh, simple dislocations, inasmuch as reduction is usually accomplished with ease, especially when use is made of an anæsthetic.

Compound dislocations are treated like open wounds of the joint (see Principles of Surgery, page 726). Reduction should be undertaken immediately, with observance of antiseptic precautions and subsequent drainage of the joint. Reduction without resection, even before the adoption of antiseptic methods, secured movable joints, according to Drewitz, in forty per cent of the cases. If reduction is attended with difficulties, the opening should be enlarged, the dislocated head laid bare, and, if necessary, the end of the humerus resected. After reduction the joint is to be carefully drained and immobilized. Resection of the head is indicated especially in case of simultaneous comminuted fracture, extensive injury of the soft parts, suppurative inflammation of the joint, and when, as has been said, reduction is unsuccessful in any other way. In case of sepsis, amputation or disarticulation may be indicated.

In case of combined dislocation and fracture of the upper end of the humerus, reduction of the dislocation should, if possible, be effected first—e. g., by direct pressure upon the head, or by exposing the joint under antiseptic precautions. The fragment may in suitable cases be united by suture or by a nail. In other cases—e. g., in fractures of

the head or of the anatomical neck—the head may be removed. If reduction is unsuccessful, Volkmann recommended that the two fragments be separated sufficiently by permanent extension so as to secure the formation of as movable a nearthrosis as possible. The method of allowing the fracture to unite and then attempting reduction is less to be recommended. The prognosis of all dislocations that are complicated by fracture must be regarded as doubtful, so far as complete recovery of the normal mobility is concerned.

Injuries of the vessels and nerves are treated according to general rules (see page 530 ff).

In old dislocations also reduction should be attempted at the outset. Dislocations have been successfully reduced with an anæsthetic even after two years. The possibility of reduction depends mainly upon the degree of the injury of the soft parts that has taken place, upon the greater or less fixation of the dislocated head in its abnormal place, also upon whether or not the glenoid cavity is seriously diminished in size or even obliterated. The rotation methods of Schinzinger and Kocher are particularly to be recommended in treating old dislocations. Kocher secured reduction by his method (see page 523) in twenty-five out of twenty-eight old dislocations, in part of them without the use of an anæsthetic. Five of these cases were of more than four months' standing. The first step consists in breaking up the adhesions about the head and making it as movable as possible by means of rotatory movements, which are to be carefully executed. At the same sitting, or a few days later, one of the methods of reduction spoken of above—Kocher's, for example—should be tried. The attempts to increase the mobility of the head may be repeated, if necessary, at several sittings. The mechanical appliances which were formerly much used, such as pulleys, crank apparatus, the extension apparatus of Schneider and Mennel, have now very properly been abandoned. If reduction is secured, the later functional result is still often defective, in spite of the use of massage and electricity and methodical exercise of the joint and the muscles. If reduction proves impossible and serious disturbances exist (pressure upon the nerves and the vessels and marked functional disability), the resection of the dislocated head is then more serviceable than simple arthrotomy. In sixteen out of twenty such resections, according to O. Knapp, a good result, and in some of them an extremely good result, was secured. Four patients died. Franz Smitel reported thirty-two resections performed upon old dislocations in Wölfler's clinic. In twenty cases, or sixty-two and a half per cent, good results were secured, while arthrotomy could show but thirty-three per cent of successful cases, and in most of these the results were but moderately good. It appears from this also that resection is better than simple arthrotomy.

In bad cases of habitual dislocation of the shoulder aseptic exposure of the joint is to be recommended, with partial excision of the loose capsule, suture of the rent, or resection of the head, according to the nature of the case. Ricard narrowed the stretched capsule without opening it by inserting a purse-string suture and immobilizing the joint for some time. The cause of habitual dislocations is sometimes, as we have seen, extensive laceration

of the muscles or breaking off of the greater tuberosity. These parts should be attached in their normal place again. Albert and others have successfully performed arthrodesis of the shoulder joint (see § 273, page 535). Good results have also been secured from subcutaneous injections of tincture of iodine (one half to three quarters of a grain at intervals of three or four days, Genzmer). In less severe cases the attempt may be made to prevent extreme movements of the arm by the use of suitable bandages.

§ 270. **Other Injuries of the Shoulder.**—Contusions and sprains of the shoulder usually occasion no serious symptoms. Contusions or bruises result from direct violence, while sprains are due to indirect violence. The latter are to be regarded as momentary incomplete dislocations, with spontaneous reduction immediately upon cessation of the traumatic influence, which was not sufficient to produce a complete dislocation. The diagnosis is based mainly upon the pain attending movements of the joint, the intra-articular and peri-articular effusion of blood, and upon the absence of all those symptoms that are characteristic of fracture or dislocation.

The treatment of contusions and sprains of the shoulder joint consists in the immediate use of massage and in active and passive movements. Ice during the first few days after the injury is but seldom necessary. For a description of massage, see *Principles of Surgery*, page 505. Paralysis of certain branches of the brachial plexus, particularly the circumflex nerve (deltoid muscle), is observed only exceptionally after severe sprains. For a description of this, the reader is referred to page 530 ff.

Wounds of the Shoulder Joint include gunshot injuries, incised wounds, punctures, machinery injuries, etc. In gunshot wounds of the shoulder joint, injury of the capsule alone is very rare. There are much more frequently injuries of the bone as well, sometimes in the form of a groove or hole in the bone, and sometimes a comminuted fracture, so that the upper end of the humerus and, it may be, the glenoid fossa are shattered into a number of fragments. There is sometimes an extracapsular fracture, and fissures extend from the injured scapula or the humerus into the joint. From a prognostic standpoint extensive injuries of the soft parts are of especial importance, particularly those of the large vessels and nerves, as well as associated injuries of the neighbouring bones and thoracic cavity.

The sooner a gunshot wound of the shoulder joint is brought under the protection of antiseptic treatment, the more likely is healing to be expected without reaction and without loss of mobility. When left alone, gunshot wounds of the joint seldom heal without subsequent supuration. Inflammation and suppuration of the joint usually develop after gunshot wounds, in consequence of the entrance of microbes.

Septic inflammation of the shoulder joint is the most unfavourable form. It may result fatally in a few days from general sepsis if provision is not made for a sufficient escape of the pus by free drainage, and, it may be, by resection of the humerus. In acute suppurative or septic inflammation of the shoulder joint the latter swells rapidly, with high fever, and movements of the joint are extremely painful. Burrowing of pus sometimes occurs—e. g., downward along the tendon of the biceps muscle or behind the subscapularis and in the direction of the axilla. A gunshot injury of the shoulder joint usually heals if treated under antiseptic precautions, with or without restriction of movement or ankylosis, or death may follow from sepsis, pyæmia, in consequence of associated injuries, etc. Extensive necrosis and a loose joint sometimes ensue.

The diagnosis of an injury of the shoulder joint from a gunshot wound is easiest when the channel made by the ball leads directly into the joint and a probe or the finger can be introduced into the latter. The diagnosis is more difficult when the joint is injured from the thorax or from the scapula, and there is no exit opening. The surest indication that the joint has been opened is the escape of synovial fluid.

Any other wound by which the shoulder joint is opened—e. g., an incised or punctured wound—be it ever so small, is also to be regarded as a serious injury, inasmuch as the function of the joint may be impaired or even the life of the patient endangered. The course of these open wounds of the joint depends primarily upon whether or not pyogenic micro-organisms have entered the joint at the time of or after the injury. Non-infected or aseptic wounds of the joint heal without reaction and without functional disturbance. The infection of a wounded joint either occurs immediately upon the infliction of the injury or later—e. g., from improper treatment, such as the use of unclean probes. In one class of cases the small wound has already closed, and then suddenly, on from the third to the fifth day, increasing inflammatory symptoms show themselves. The joint swells and becomes tense and painful, the skin is red and feels hot, and there is a high temperature. If the agglutinated edges of the wound are separated with a probe, or if any sutures that have been inserted are removed, pus makes its appearance. The course is at other times subacute, and a more chronic suppuration follows. In other cases severe local and general symptoms appear within twenty-four hours after the injury. If the joint is not opened at once, irrigated with antiseptic solutions and drained, or, if necessary, the head resected, the process may go on to acute suppurative destruction of the joint with general sepsis. This septic arthritis may have such a rapid course

that even on the fourth or fifth day it may be impossible to save the patient by disarticulation of the shoulder. A wound of the shoulder joint resulting from a stab or a cut terminates, therefore, either in complete return to the normal or in more or less serious functional disturbance, which may amount to complete ankylosis, or, finally, in death from sepsis or pyæmia. Disarticulation of the humerus is sometimes necessary. In all fresh injuries that are brought under immediate treatment the escape of synovial fluid is, as has been said, of especial importance for the diagnosis of a wound that involves the joint. In cases where the joint is widely opened one can see the articular cartilage lying bare. If the wound is small and its edges agglutinate quickly, only the later course shows whether or not the joint has been entered. One should be cautioned against too much probing in connection with wounds of the joints, or, at all events, against the use of any probes that are not strictly aseptic.

The treatment of every wound of the joint, even the smallest, must be carried out with the greatest care.

The treatment of gunshot wounds varies in war and peace. In war an antiseptic, expectant treatment should be employed at first, with the application of an occlusive dressing (Bergmann, Reyher) if associated injuries—e. g., of the blood-vessels—do not necessitate immediate action. There is no time upon the battlefield for regular antiseptic treatment, with drainage and resection of the joint. This should be carried out in the hospitals, where the same methods of treatment are used as in peace. In treating gunshot wounds of the shoulder joint in peace the joint should be drained, the ball and any foreign bodies that may have entered the wound removed, the shattered bone resected, completely detached splinters of bone extracted, etc. In case suppurative inflammation of the joint is already present, resection of the humerus is likewise indicated, and the latter must be performed as carefully as possible in order that a loose joint may not result. Disarticulation of the humerus is indicated in case of severe injury of the soft parts—e. g., of the vessels and the nerves when preservation of the arm is impossible, and also in case of septic inflammation of the joint if the life of the patient is endangered.

The same principles are applicable in treating other wounds of the shoulder joint, such as of those, for example, caused by a cut or a stab. An expectant treatment will often be adopted, especially in dealing with small wounds which have already closed, where there is uncertainty whether or not the joint has been opened. Every recent unmistakable wound of the joint should be disinfected, enlarged if necessary, drained, and immobilized by an antiseptic dressing. If there is already

inflammation or suppuration of the joint, the latter should be freely opened, disinfected, and drained. Resection of the head of the humerus is usually indicated in case of extensive suppuration in order to secure better drainage. Disarticulation may be necessary in case of septic inflammation of the joint where death from general septic infection is threatened.

§ 271. **Injuries of the Vessels and Nerves of the Axilla.**—We have already described injuries and ligation of the subclavian artery and vein in vol. ii, § 90, page 519 ff. Injuries of the axillary artery arise especially from gunshot and stab wounds, in connection with injuries from machinery, from compound comminuted fractures of the upper end of the humerus and dislocations, also from erosion of the vessel by a suppurative process, etc. Complete division of the artery usually results in immediate death from hæmorrhage. In case of partial division of the wall of the vessel by a stab wound, a so-called traumatic aneurism or hæmatoma may be formed, which is then gradually transformed into a genuine aneurism. In the latter case there is a characteristic, pulsating tumour, with a *bruit*. The hæmorrhage is sometimes temporarily arrested in wounds of the large arteries by coagulation of the extravasated blood, the hæmatoma, and then fatal secondary hæmorrhage may suddenly ensue. The latter is especially to be feared when the extravasation of blood suppurates. After partial ruptures of the axillary artery—e. g., laceration of the intima and the muscular coat—gangrene of the arm may result from the formation of an embolus extending into the subclavian. Even after injury of the subclavian artery, however, gangrene of the arm is rare. It was observed but twice among ninety cases (Bergmann).

The diagnosis of an injury of the axillary artery is easy in open wounds, in consequence of the profuse hæmorrhage. In doubtful cases it is based upon the presence of a hæmatoma or traumatic aneurism, and upon the location and the direction of the wound.

Death from the entrance of air may follow open wounds of the large vessels of the axilla, especially when the arm is thrown upward and backward, so that the wound in the subclavian vein gapes widely, in consequence of the elevation of the clavicle. Large amounts of air may be aspirated into the open vein in such cases in consequence of the negative intrathoracic pressure, and the patient then dies of paralysis of the heart during the diastole, because the air collects in the right ventricle. (For particulars see Principles of Surgery, page 60.)

The treatment of an injury of the large vessels in the axilla, the arteries, as well as the veins, consists in their double ligation in the wound. Branches that go off near the wounded portion of the vessel

should likewise be tied, as otherwise secondary hæmorrhage ensues after the establishment of the collateral circulation. The hæmorrhage is arrested temporarily by compression of the wound until the vessels are tied.

Ligation of the Axillary Artery is performed as follows: The arm is abducted at right angles from the body and rotated slightly outward. The anterior boundary of the axilla is formed by the pectoralis major muscle, the posterior boundary by the latissimus dorsi and the teres major. Between these two folds lies the axillary space. The belly of



FIG. 652.—Ligation of the axillary and brachial arteries.

the coraco-brachialis muscle is usually to be felt and seen in the latter (Fig. 652). Along the lower edge of this muscle or the border of the hair, the skin, the subcutaneous tissue, and the axillary fas-

cia are divided longitudinally to the extent of about six centimetres. Upon dissecting inward at the lower border of the coraco-brachialis the large axillary vein appears, and on its upper border one sees the median and the middle cutaneous nerves. If the vein is drawn downward the ulnar nerve comes into view, and between the median and the ulnar nerves lies the axillary artery, usually covered in part by the median nerve. Care should always be taken to have the arm kept in the same position, as otherwise the nerves and the artery become correspondingly displaced.

Aneurisms of the Axillary Artery are rare and usually occasion disturbances only when they have reached a considerable size (pressure upon the brachial plexus, disturbance of the circulation in the hand and arm, etc.). For the etiology, diagnosis, and treatment of aneurisms, the reader is referred to Principles of Surgery, page 532 ff. The treatment consists in digital or instrumental compression, in suspension of the arm, and, when possible, in ligation of the axillary artery proximally and distally from the aneurism, and splitting the sac (Antyllus). Proximal ligation of the axillary or subclavian artery, after Anel and Hunter, or distal ligation of the axillary, are less certain in their effect. Of seventy-five cases of ligation of the subclavian artery, twenty-eight, according to Wyeth, terminated fatally. If operative treatment of the aneurism is no longer possible, I can recommend electro-puncture, for the technique of which the reader is referred to vol. ii, § 131, page 724. In case of syphilis improvement has been secured by antisypilitic treatment (iodide of potassium, mercury), with or without the use of the galvanic current.

§ 272. **Injuries of the Brachial Plexus.**—We have already referred to injuries of the brachial plexus in the region of the clavicle in vol. ii, § 91, page 526. Injury of the brachial plexus in the axilla is, generally speaking, rare. It consists here also partly in contusion of the nerves or in complete or incomplete division of the single nerves. Here belong also paralyses of the brachial plexus from compression caused by callosities due to the use of insufficiently padded crutches (“crutch paralyses”). The latter have usually a favourable prognosis. They soon disappear if the patient uses more suitable crutches or leaves them off altogether. Combined paralyses in the distribution of the brachial plexus and isolated paralyses of one of the main nerve trunks have been observed after prolonged anaesthesia, during which the patient’s arm was kept elevated alongside the head. This form of paralysis is supposed to be due to pressure of the clavicle against the comparatively superficial portion of the brachial plexus which arises from the union of the fifth and sixth cervical nerves. Injuries of the nerves of the axilla are followed by motor and sensory paralyses corresponding to the region which they supply. For the characteristic paralyses of the main divisions of the brachial plexus, the median, the musculo-spiral, and the ulnar nerves, the reader is referred to paralyses of the hand (§ 295). Complete recovery has been known to follow severe wounds of the brachial plexus both with and without neurorrhaphy when it has not been in the least anticipated (Tiedemann, Langenbeck, Huetter; see Principles of Surgery, page 473).

Other nerves may be involved reflexly by injuries of the brachial plexus. Pirogoff saw neuralgia of the phrenic nerve and of an intercostal nerve after injury of the brachial plexus. The paralysis may also extend to the brachial plexus of the other side from ascending neuritis (Stromeyer). Paralysis of the brachial plexus, with simultaneous paralysis of the sympathetic nerve (contraction of the palpebral fissure and the pupil, atrophy, and hyperæmia of the cheek), has been observed by Seeligmüller, Bärwinkel, and others.

The treatment of injuries of the brachial plexus conforms to general rules. Neurorrhaphy is indicated in case of complete division. In case of large defects the attempt is made to unite the ends of the nerve directly by stretching them, or pedunculated flaps are formed from one or both stumps (see § 295), or a piece of nerve is transplanted into the defect—from a rabbit, for instance. For neurorrhaphy, the operative treatment of defects in the nerves, and nerve regeneration, the reader is referred to § 295 as well as to the detailed description in Principles of Surgery, pages 469–475.

Of paralysees of other nerves in the region of the shoulder I mention especially the following :

Injury of the circumflex nerve is not rare in fractures and dislocations of the shoulder joint in consequence of its course about the humerus. It supplies the *teres minor* muscle in part, most of the *deltoid*, and a portion of the *subscapularis*. Injury of the nerve should be avoided as far as possible in performing operations in the axilla—e. g., in the extirpation of carcinomatous glands after amputation of the breast. The principal symptoms of an injury of the circumflex nerve are paralysis of the muscles named, especially atrophy of the *deltoid* muscle, impaired elevation of the arm, and displacement of the head of the humerus downward and inward.

Injury of the subscapular nerve is observed in connection with fractures and diseases of the scapula and sometimes from cleaning out the axilla after amputation of the breast (Küster). The nerve supplies the *subscapularis*, the *teres major*, and the *latissimus dorsi* muscles. After injuries of the subscapular nerve, reflex spasm of the phrenic nerve is sometimes observed, with *singultus*, *dyspnœa*, and girdle pains.

The suprascapular nerve, which supplies the *supraspinatus*, the *infraspinatus*, and the *teres minor* muscles, is most likely to be injured in connection with fractures of the scapula. External rotation is interfered with and the arm is adducted and rotated inward.

Paralysees of the long thoracic nerve (external respiratory nerve, Bell) are of especial interest. The long thoracic nerve arises from the fifth, sixth, and seventh cervical nerves, and passes through the *scalenus medius* muscle and along the side of the chest to the *serratus magnus*. In consequence of



FIG. 653.—Paralysis of both *serratus magnus* muscles.



FIG. 654.—Paralysis of both *serratus magnus* muscles.

its unfavourable location, the nerve is often affected by traumatism and inflammatory processes. Paralysis of the *serratus magnus* muscle is also observed in connection with progressive muscular atrophy. The paralysis is sometimes unilateral, sometimes bilateral, and almost always of peripheral origin. Paralysis of the *serratus magnus* alone is very rare. Other adjacent muscles are usually more or less paralyzed, especially the *trapezius*, the *levator anguli scapulæ*, the *latissimus dorsi*, and the *rhomboid* muscles,

which are supplied by the supraclavicular, the dorsalis scapulæ, and the subscapular nerves. In isolated paralysis of the serratus magnus the scapula is not sufficiently fixed. If the arm is abducted and raised to the horizontal, the posterior border of the scapula is then displaced as far as the spinal column, and in case both muscles are paralyzed, the scapulæ come in contact in the middle line (Fig. 653, after W. Busch), the scapula following the traction of the rhomboid and the trapezius muscle. If the patient tries to move the arm forward, the posterior border of the scapula is raised from the thorax like a wing (Fig. 654, after W. Busch). The most important functional disturbance, however, is the patient's inability to raise the arm above the horizontal, owing to the fact that the rotation of the scapula, which is accomplished by the serratus magnus and the trapezius muscles, is prevented, the latter muscle not being able to execute this movement alone. In most cases, as has been said, the trapezius, the rhomboid, the levator anguli scapulæ, and the latissimus dorsi muscles are paralyzed at the same time, and the typical picture of isolated paralysis of the serratus magnus muscle is then correspondingly modified.

The extent of the paralysis should be determined by careful electrical examination.

The treatment of the paralyses that have been mentioned varies with the cause. It may be operative—e. g., in case of division of the nerves, their compression by cicatricial bands, etc.—or use may be made of electricity, massage, and active and passive movements. In case of incurable paralyses the attempt should be made to improve the condition by braces, etc. In case of paralysis of the serratus magnus muscle, for example, the ability of the arm to perform its function may be increased by a brace which supports the shoulder and presses the lower angle of the scapula against the thorax.

Neuralgia of the brachial plexus and its branches results from injuries, inflammation, pressure from cicatrices or masses of callus, from adhesion of the nerves or the nerve sheaths with the adjacent parts, from hysteria, anæmia, etc. The treatment of the more or less intense paroxysms of pain that occur depends chiefly upon their cause, which should be carefully investigated. Electricity, narcotics (morphine, atropine), arsenic, quinine, bromide and iodide of potassium, strychnine, massage, or baths should be made use of according to the nature of the case. Hysteria and anæmia are to receive appropriate treatment; cicatrices or masses of callus that cause pressure are to be removed, etc. (see also Principles of Surgery, page 300). Purely sensory nerves should be resected, and in suitable cases the brachial plexus may be stretched. Out of fifteen cases of traumatic neuralgia favourable results ensued in ten from stretching the nerves; in these the nerve sheath was first opened and separated from the nerve. For the technique of stretching the nerves of the brachial plexus in the supraclavicular fossa, the reader is referred to vol. ii, § 91, page 527. If it is desired to stretch the brachial plexus in the axilla, it should be exposed by an incision along the lower border of the coraco-brachialis muscle, as in ligation of the axillary artery the individual nerve trunks should be carefully sought out and isolated from the vessels and then stretched in both directions until a distinct elongation of the nerves is demonstrable.

§ 273. **Deformities in the Region of the Shoulder.**—Of congenital deformities in the region of the shoulder I mention first partial or complete absence of the clavicle, which is of very rare occurrence. Kappeler observed absence of both clavicles (Fig. 655). There was only a rudimentary clavicle one centimetre long on the right side and one four centimetres long on the left side. These articulated on both sides with the sternum, and laterally ended free in the soft parts. The patient's arms could be brought close together upon the chest (Fig. 655). There was no marked functional disability.



FIG. 655.—Congenital absence of both clavicles.

I observed in the case of an otherwise sound girl of eight years congenital displacement of the right scapula upward for a distance of about four centimetres without functional disturbance of the involved arm (Fig. 656). The trapezius muscle on the right side was correspondingly shortened, but showed the same conditions, so far as volume and contractility are concerned, as on the left. Similar cases have been described by Sprengel, Schlange, Permann, Bolten, and others. This congenital elevation of the scapula has been observed more frequently on the left side than on the right. The deformity was on the left side in eight out of thirteen cases. There is usually a slight scoliosis of the spine. The deformity probably arises from a variety of causes, particularly from abnormal position of the foetus in the uterus, and from disproportion between the size of the foetus and the uterine cavity, much as in torticollis and clubfoot. No treatment is, as a rule, necessary in such cases. Hoffa, in one case, divided the muscles, which prevented the drawing down of the scapula with gratifying success. The scapula was held down by elastic traction on a scoliosis jacket.

Congenital Dislocations of the Shoulder Joint, which are very rare, may be unilateral or bilateral. We have really to do in this condition with an abnormal location of the head of the humerus with a loose joint. Congenital subcoracoid dislocation and backward dislocation are the most common (P. Voigt), with formation of a new glenoid cavity in an abnormal place and absence of the normal cavity. All congenital dislocations of a joint are really foetal malformations of that joint. A closed capsule is present, but the joint is in an abnormal place. The analogous abnormalities in the situation of the head of the humerus, which occur at birth or after birth, and likewise cause a loose

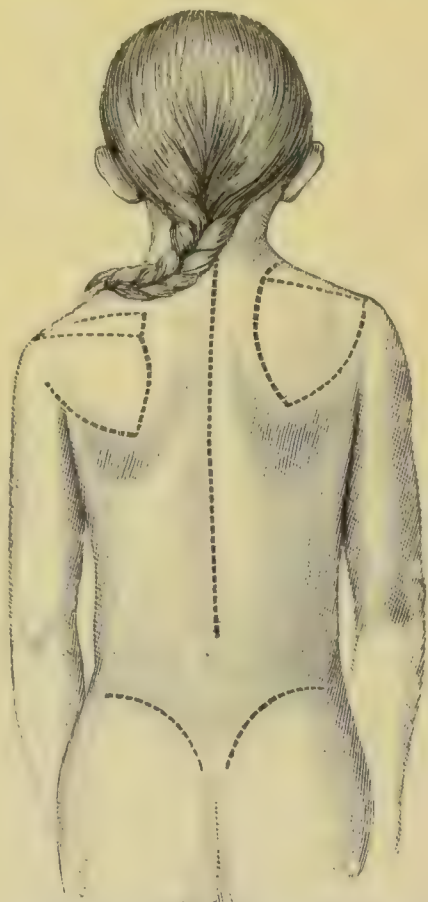


FIG. 656.—Congenital upward displacement of the right scapula in a young girl of eight years.

joint, are not to be confounded with those extremely rare disturbances in the development of the shoulder joint which occur *in utero*. The former arise from injuries of the articular apparatus, the bones, or the soft parts during delivery—e. g., from epiphyseal separation, traumatic paralysis of the brachial plexus, the deltoid muscle, etc. (paralytic loose joint, Fig. 657). Dislocations proper do not occur during birth, because the epiphyses usually separate first. Paralytic loose joints, with displacement of the humerus downward and inward, arise also from early spinal and cerebral paralysis of the muscles of the shoulder. Moreover, the paralytic dislocations of the shoulder that occur later in life from paralysis of the shoulder muscles present usually the appearance shown in Fig. 657.

All the malformations or functional disturbances of the shoulder joint which have been mentioned as congenital or as acquired soon after birth are frequently overlooked at first, and therefore do not come under treatment until later, especially separation of the epiphysis and injuries to the brachial plexus from difficult deliveries. All children delivered by version and extraction should be carefully examined with reference to the existence of an epiphyseal separation, in order that a proper treatment may be begun as soon as possible. Spinal infantile paralysis of the upper extremity is rare, and is usually observed in the first years of childhood in children of normal birth.

In cases of congenital dislocation of the shoulder every form of treatment, operative as well, is powerless. The deformities of the shoulder joint that arise at birth, the separations of the epiphysis and traumatic paralyses, are treated according to general rules. In case of separation of an epiphysis one should lay a wad of cotton in the axilla and fix the arm to the thorax for about two weeks. One then seeks, by means of massage and gentle passive movements, to improve as soon as possible the impaired nourishment of the muscles and the stiffness of the joint. In cases of traumatic paralysis, electricity, massage, and methodical exercise of the muscles and the joint should be employed. In all separations of the epiphysis which have united with deformity and in cases where paralysis of the muscles of the shoulder has become permanent there is little to be accomplished by treatment, save when the paralysis is conditioned upon compression of the nerves by a hypertrophic callus. In such cases a cure may be obtained by the removal of the callus which causes the pressure.

The function of paralytic loose joints may be restored in part by arthrodesis or artificial ankylosis of the joint, and surprisingly good results have been secured in this way, especially in the case of the shoulder joint (Albert, Nicoladoni, Rydygier, Petersen, Julius Wolff, the author, and others). After the joint has been opened, which is best accomplished in its posterior part, along the border of the glenoid cavity, the cartilaginous surface of the humerus and the glenoid cavity are freshened with a chisel and the head of



FIG. 657.—Paralytic loose joint. The acromion, coracoid process, and the head of the humerus, which is displaced downward, are plainly visible.

the humerus fastened to the cavity with ivory nails or steel needles, or simply by sutures of silkworm gut, catgut, or silver wire. As the result of the anchylosis, the patient, by rotation of the scapula, can raise his arm, lower it, and also abduct and adduct it somewhat. The operation is, of course, to be undertaken only when massage, electricity, active and passive movements, etc., are without effect. Arthrodesis has also been performed in the worst cases of habitual dislocation of the shoulder with good results—e. g., by Albert.

§ 274. **Diseases of the Bursæ in the Vicinity of the Shoulder.**—

Among the bursæ in the vicinity of the shoulder the acromial bursa, the subacromial bursa, the subscapular bursa, the subcoracoid bursa, and the subdeltoid bursa come especially under consideration.

1. The acromial bursa, situated over the acromion process, is not infrequently the seat of acute and chronic inflammation among people who are accustomed to carry heavy burdens on the shoulders.

2. The subacromial bursa lies beneath the acromion. It is less often diseased.

3. The subscapular bursa has a very hidden location in the subscapular fossa between the subscapularis muscle and the neck of the scapula, close behind and under the coracoid process. It is to be regarded as a synovial protrusion of the shoulder joint, with which it has a free communication.

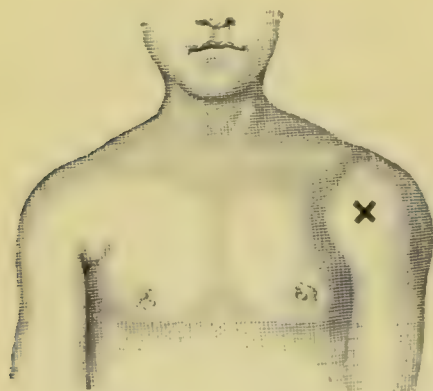


FIG. 658.—Hygroma (x) of the subdeltoid bursa.

4. The subcoracoid bursa, beneath the coracoid process and between the origin of the coraco-brachial muscle and the subscapularis muscle, often communicates with the subdeltoid bursa.

5. The subdeltoid bursa, beneath the deltoid muscle (Fig. 658), varies greatly in size. It communicates with the shoulder

joint, especially among aged people, in consequence of atrophy of the dividing wall.

In addition to these more or less constant bursæ of the shoulder joint, I mention the occurrence of one upon the coracoid process and another in its neighbourhood—e. g., forward and inward in the angle between the conoid and trapezoid ligaments, as well as one in the loose connective tissue between the serratus magnus muscle and the thoracic fascia, and, finally, the bursa anguli superioris scapulæ (Fig. 659).

All the bursæ that have been named may become the seat of acute or chronic inflammations. Bloody serous or suppurative effusions are observed, especially after injuries, as well as tubercular processes. Extensive burrowing of pus sometimes occurs, with rupture, it may be,

into the shoulder joint—e. g., after primary inflammation of the subscapular bursa, which always communicates with the shoulder joint. In other cases the reverse is true—i. e., primary inflammations of the shoulder joint involve the subscapular bursa. Serous collections in the bursæ (hygromata) arise also from continued pressure or from friction—e. g., in the acromial bursa among individuals that carry burdens, with the formation of circumscribed fluctuating tumours upon the acromion reaching the size of a walnut or an apple. Free bodies, so-called rice bodies, corpora oryzoidea, are not infrequently found in these swellings (see also Principles of Surgery, page 559). Effusions in the subdeltoid bursa (Fig. 658) and the acromial bursa are the most superficial, and are therefore most easily recognised. For the diagnosis of a hæmatoma and acute or chronic bursitis the location of the circumscribed fluctuating tumour resulting from a collection of blood, serum, or pus is especially important, as are also pain at a definite place, crepitant sounds, etc.

The treatment of acute serous or suppurative bursitis consists in incision and drainage. In cutting down upon a bursa the anatomical relations of the bursa in question must be carefully considered. Incision and scraping out of the bursa are also to be performed in case of simple chronic bursitis or tubercular disease. In case of purely serous accumulations, puncture of the bursa, with or without subsequent injection of tincture of iodine, is often sufficient. Free incision is, however, always preferable to the latter method of treatment.

§ 275. **Inflammations of the Shoulder Joint.**—The various forms of acute and chronic arthritis, as described more fully in Principles of Surgery, §§ 113–119, occur in the shoulder joint—that is, acute and chronic serous and sero-fibrinous inflammations, acute and chronic suppurative inflammations, the various forms of tubercular and syphilitic arthritis, rheumatic inflammations, arthritis deformans, neuropathic arthritis—e. g., in syringomyelitis or gliomatosis of the spinal cord, and joint neuroses. The slight serous and sero-fibrinous inflammations of the shoulder joint are easily overlooked, as the joint is surrounded on all sides by soft parts. The existence of such small inflammatory effusions is best made out from the axilla. In all cases of distention of the joint—e. g., by blood or serum—it can be seen that the swelling conforms exactly to the contour of the joint capsule. The most im-

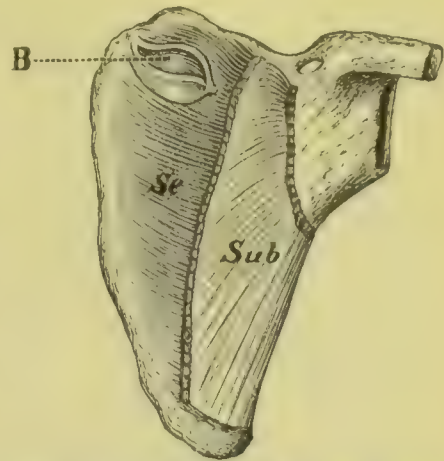


FIG. 659.—*B*, Bursa at the upper angle of the scapula; *Se*, the serratus magnus muscle; *Sub*, subscapularis muscle (Gruber).

portant symptom in all acute and chronic inflammations of the shoulder joint is the interference with its function, especially with abduction and elevation of the arm, when the shoulder or the scapula is fixed. After long continuance of a chronic inflammation the upper arm usually sinks downward and inward of its own weight, in consequence of the relaxation and stretching of the capsule as well as from the atrophy of the muscles. As a result of the distention of the capsule by fluid and of the deformation of the bones making up the joint, the various forms of pathological luxations and subluxations are observed.

Acute and chronic serous or sero-fibrinous inflammation of the shoulder joint occurs, especially after traumatism, with an effusion of blood into the joint—e. g., after sprains, also in the course of acute and chronic articular rheumatism, etc. It is characterized by the presence of a variable amount of serous or sero-fibrinous effusion, with or without the formation of inflammatory fibrous tissue over the cartilaginous surfaces. The chronic forms of inflammation usually result from the acute forms, or they may begin very gradually as such. In the latter case they are often of a tubercular nature. The joint is in rare cases tensely filled, so that the humerus is then somewhat abducted and rotated inward (Bonnet). Incomplete or complete dislocations of the head of the humerus occur, in exceptional cases, in consequence of the distention of the capsule. Of equally rare occurrence is rupture of the capsule from the same cause—e. g., in the vicinity of the sheath of the tendon of the biceps muscle and under the subscapularis muscle.

The diagnosis of serous or sero-fibrinous synovitis of the shoulder joint is determined, in case of a large effusion within the joint, by fluctuation or a bulging in the vicinity of the bicipital groove, in the axilla, and in the region of the subscapular bursa—that is, near the coracoid process and posteriorly in the infraspinous fossa. A similar bulging is observed also in case of an effusion in the subscapular bursa. In case of acute inflammation, pain also is present at the places named, particularly on pressure. The functional disturbance consists chiefly in interference with raising and abducting the arm, and the longer the inflammation has existed the more decided is this limitation of motion. Milder forms of serous and sero-fibrinous arthritis are easily overlooked.

Acute and chronic suppurative inflammation of the shoulder joint is the result most commonly of penetrating injuries of the joint, including gunshot wounds, of the greatest variety of infections—e. g., scarlet fever, smallpox, typhoid, pyæmia, acute osteomyelitis, etc. Every case of acute suppurative arthritis of this joint is characterized by

fever, severe inflammatory swelling, great tenderness, and decided functional disturbance of the joint. The skin feels hot and is red-dened, and the arm is more or less oedematous. The fluctuation becomes more and more distinct as the accumulation of pus increases. Periarticular abscesses and burrowing of pus not infrequently result. The worst form is the septic inflammation of the joint. The termination is either complete return to the normal, especially in case of prompt antiseptic treatment, or recovery attended with partial or complete ankylosis, or, finally, death. Among chronic suppurative processes in the shoulder joint, the tubercular inflammations especially interest us.

Tubercular arthritis of the shoulder joint sometimes takes the form of destruction of bone without marked formation of pus (*caries sicca*), sometimes of chronic tubercular suppuration with the formation of abundant fungous granulations. In *caries sicca* resulting from tubercular osteomyelitis, the entire head of the humerus may be destroyed without appreciable suppuration, and the joint being thus destroyed, the tubercular disease may undergo spontaneous cure in from one to four years with ankylosis. The destruction of the head often progresses very rapidly. It makes itself apparent by a flattening of the shoulder, by adduction of the arm, and by fixation of the head which has sunk downward and inward. The other form of tubercular arthritis of the shoulder joint, which has its origin more frequently in the synovial membrane, but sometimes also in the bone, runs its course with a more abundant formation of pus and fungous granulation tissue. The tubercular process not infrequently begins with a serous or sero-fibrinous effusion (tubercular synovitis). There are numerous transitions between the two principal forms. The reader is referred, for a more detailed statement regarding tuberculosis and tubercular joint inflammations, to *Principles of Surgery*, § 83, page 406 ff., and § 114, page 672 ff.).

Syphilis is but seldom located in the shoulder joint. The early forms of syphilitic arthritis—e. g., at the time of the eruptive fever—consist essentially of a serous effusion, while the affections of the joint in the later stages of syphilis are usually conditioned upon the formation of gummata in the periosteum, in the bone marrow, and in the synovial membrane. In still other cases an indurative or villous proliferation of fibrous tissue is more prominent.

The inflammations at the upper epiphyseal line, with separation of the epiphysis and necrosis, are of especial interest—e. g., in acute osteomyelitis, in tuberculosis, and syphilis. If the joint is not involved in the inflammation either primarily or secondarily, the termination is usually favourable as regards the function of the joint, but marked shortening may arise in consequence of the disturbance in the longitudinal growth of the arm.

Arthritis deformans (see Principles of Surgery, page 683) of the shoulder joint is observed especially among older people, but occasionally also among the young. It is characterized by degenerative and at the same time hyperplastic processes in the cartilage and the bone. The pronounced increase in volume or atrophy of the head of the bone, the presence of friction sounds



FIG. 660.—Defect in the biceps tendon caused by a process of fibrillation in arthritis deformans.

in consequence of fibrillation of the cartilage, the cartilaginous or bony projections, and the loose bodies in the joint, are especially important in the diagnosis of this affection. The destruction of tissue not infrequently extends to the tendon of the biceps muscle. This becomes fibrillated, and the fibrillation is usually intracapsular at the beginning, then progresses to the periphery, and may lead to marked defects with complete loss of function of the tendon (Fig. 660).

Acute and chronic rheumatic inflammation of the shoulder joint is rather common. Acute articular rheumatism is an infectious disease, conditioned upon micro-organisms which invade the joints and other serous surfaces—e. g., the endocardium. The inflammations of the different joints are usually of a serous but sometimes also of a suppurative character. By chronic articular rheumatism is understood an inflammation of the synovial membrane with an extremely protracted

course, which occurs almost exclusively among adults, usually after the thirtieth or fortieth year, and which always affects several joints simultaneously. The anatomical changes that attend chronic articular rheumatism closely resemble arthritis deformans, the difference being that in the latter the proliferation of cartilage, and in the former the displacement of the cartilage by vascular fibrous tissue, is more prominent. Chronic articular rheumatism is observed most frequently among the lower classes, and hence the designation arthritis pauperum. Colds, exposure, living in a damp house, etc., are the chief causes. The disease usually leads to gradually increasing stiffness of the joint, to ankylosis.

Hysterical disease, or neuralgia of the shoulder joint (see Principles of Surgery, page 690), is very common, and is characterized particularly by pain which comes spontaneously and in attacks, especially among hysterical and nervous individuals. No definite anatomical change is demonstrable. The diagnosis of pure neuralgia of the shoulder joint is often difficult, as the cause may sometimes be an inflammation of the joint or the bone, which is easily overlooked. The occurrence of the pain in attacks, the absence of pathological changes, and the nervous condition of the patient, are of especial importance in making the diagnosis.

Ankylosis or stiffness of the shoulder joint is a frequent result of the inflammations that have just been described, especially of acute and chronic suppurative arthritis, chronic rheumatic arthritis, etc. There is a distinction between true and false ankylosis. By false

anchylosis is understood one in which an apparently immovable joint—the result, for example, of acute or chronic arthritis with inflammatory or voluntary muscular contraction, of hysterical arthritis, etc.—becomes movable again when the patient is under an anæsthetic. True anchylosis of the shoulder joint is conditioned upon firm fibrous, cartilaginous, or bony union of the joint surfaces, upon cicatricial contraction of the capsule, upon the adhesion of two opposed portions of the synovial membrane, upon deformation of the bones making up the joint, upon inflammatory or cicatricial processes in the neighbourhood of the joint, etc. The arm can be moved backward and forward in conjunction with the scapula, even in case of complete anchylosis, while abduction, external rotation, and elevation of the arm beyond the horizontal are interfered with, more or less, according to the degree of the anchylosis.

The treatment of the various forms of arthritis of the shoulder conforms to general rules, as we have given them more in detail for the different forms of arthritis in *Principles of Surgery*.

The treatment of acute serous inflammation of the shoulder consists at first in keeping the joint still (sling) and in the use of ice. After the inflammatory symptoms and the pain have subsided, massage and methodical movements of the joint are employed. Compression can not usually be employed satisfactorily in the case of the shoulder joint, on account of the pressure upon the vessels and the nerves of the axilla. In case of great distention of the joint, aseptic puncture or incision of the joint is to be recommended, with subsequent irrigation of the same with a three-per-cent solution of carbolic acid or a 1 to-1,000 solution of bichloride, especially where there is a sero-fibrinous effusion with flakes of pus. The joint is then immobilized by means of a sling and a spica bandage (see *Principles of Surgery*, Fig. 138, page 191, and Fig. 155, page 197), or in the way shown in Fig. 618, page 494, Figs. 620 and 622, page 495, of this volume.

The treatment of a chronic effusion into the shoulder joint is the same as that for the acute form. It consists chiefly in massage, methodical exercise of the joint, and it may be in aseptic puncture or incision, with or without subsequent irrigation of the joint, followed by immobilization.

Mild cases of acute suppurative arthritis of the shoulder joint should be treated at the outset by aseptic puncture or incision, with subsequent irrigation of the joint with a three-per-cent solution of carbolic acid or 1-to-1,000 bichloride. In case of severe suppuration attended with high fever, free incision and drainage of the joint are indicated, and it may be resection of the humerus. The joint should always be

drained at the most dependent part—e. g., at the posterior border of the deltoid muscle, with the shoulder lowered. If the life of the patient is endangered it may become necessary to disarticulate at the shoulder joint. If recovery attended with mobility of the joint follows suppuration of the shoulder joint, the mobility is to be aided, after the inflammation has entirely subsided, by passive movements, massage, and electricity. If ankylosis is threatened, the joint must be kept in an extended and slightly abducted position.

The treatment of acute articular rheumatism consists in immobilization of the joint, in giving it a suitable position, and in the use internally of diaphoretics and diuretics (especially salicylic acid and salicylate of soda, three to five grammes a day). In cases of chronic rheumatic arthritis of the shoulder that is not of long standing use is made of massage and methodical exercise of the joint, also of baths, steam baths, rubbing with cold water, and various thermal springs (Gastein, Teplitz, Wiesbaden, Ragaz, etc.). Residence in southern climates is also very advantageous. Cod-liver oil, iron, iodide of potassium, salicylic acid, salicylate of soda, etc., are given internally.

In treating tuberculosis of the shoulder joint, intra-articular injections of ten-per-cent sterilized iodoform glycerin, or iodoform oil, at intervals of from two to four weeks, are to be tried at the beginning (one to five grammes or more according to the age of the patient). Scraping out the joint with a sharp spoon, or, if necessary, resection of the humerus, are to be undertaken in advanced cases. In syphilitic arthritis an antisiphilitic treatment (mercury, iodide of potassium) is to be adopted in addition to a proper local one. See also Principles of Surgery—Tuberculosis, Syphilis, Diseases of the Joints.

The treatment of arthritis deformans of the shoulder consists chiefly in massage and methodical movements of the joint, in the use of baths (vapour, mud, and sand baths, etc.) and in hot springs (Gastein, Wildbad, Wiesbaden, Teplitz, Ragaz, etc.). Serious functional disturbances are overcome by resection of the humerus.

In hysterical disease of the shoulder joint the underlying cause is first of all to be overcome. The local treatment consists in massage, methodical movements, rubbing with cold water, baths, and the use of electricity. Quinine and arsenic are given internally, and, in case of severe paroxysms of pain, use is made of hypodermic injections of morphine or atropine.

In suitable cases of ankylosis of the shoulder joint, especially when the position of the arm is defective, resection of the humerus is indicated. Malpositions of the joint may also be overcome by osteotomy of the humerus near the joint (see also Principles of Surgery, page 698).

It is of the greatest importance in the treatment of all inflammations of the shoulder joint that the atrophy of the muscles of the shoulder, especially of the deltoid, be prevented as far as possible. After the arthritis has had its course the muscles should be strengthened again as soon as possible by the use of massage and electricity and by active and passive movements.

§ 276. **Inflammatory Processes in the Axilla.**—The skin of the axilla is frequently the seat of eczema resulting from excessive perspiration and of erythema, especially in summer. These inflammations of the skin are treated by smearing the axilla with unguentum diachylon and powdering it with oxide of zinc or amylum. Abundant growth of hair in the axilla is to be removed, if necessary, by shaving. Bathing the parts with cold water is also serviceable in treating erythema.

For the prevention of excessive secretion of sweat (hyperidrosis) with a penetrating odour and discoloration of the clothing, disinfecting washes are to be recommended and inunction with unguentum diachylon, as well as powdering with oxide of zinc, bismuth, or amylum, also five-per-cent solutions of chromic acid (see also Sweating Feet).

Furuncles often occur in the axilla in consequence of acute inflammation of the hair follicles and sebaceous glands, which may give rise to deep and extensive abscesses, with numerous fistulous tracts. These furuncles should be incised as soon as possible under local anæsthesia (ether spray, cocaine, or menthol). Abscesses and fistulous tracts are to be freely opened and scraped out with a sharp spoon.

Acute and chronic inflammations of the lymph glands of the axilla (axillary lymphadenitis) are very frequent. Acute axillary adenitis is often observed after the infection of wounds of the finger, not infrequently of the most insignificant character, with or without demonstrable lymphangitis of the arm from the point of infection as far as the axilla; also in furunculosis of the axilla, and among women from fissures of the nipples, etc. Acute suppurative inflammation of the lymph glands may lead to a very large abscess or to a rapidly progressive, deep phlegmon, which may spread to the region of the clavicle or lead in turn to extensive burrowing of pus down the arm, beneath the pectoralis major muscle, and in the direction of the scapula, if not incised with sufficient promptness. One should always in such cases open the pus focus freely in the longitudinal direction of the axilla and scrape it out. Proper attention should be paid to any gravitation abscesses. The cavity should be packed with iodoform gauze, an antiseptic protective dressing applied, and over this a shoulder spica (see Principles of Surgery, Fig. 138, page 191).

Chronic axillary lymphadenitis is either a simple (scrofulous) hyper-

trophy of the glands or a tubercular caseous or suppurative inflammation of the same. The best treatment in both cases consists in the removal of the diseased glands. Scraping with a sharp spoon is usually insufficient of itself, especially when they have broken down and formed fistulous tracts. There is also a chronic suppurative inflammation of the axillary glands with or without fistula formation which results from pyæmic infection—e. g., after injuries of the finger—and is to be looked upon as a chronic pyæmia. Such latent pyæmic pus foci in the axilla sometimes occasion acute exacerbations, after injuries for instance, and may then prove fatal from metastatic pyæmia at a time when the original point of infection, such as a cellulitis of a finger, has long been forgotten. The abscess in the axilla must in such cases be freely incised and drained.

In other cases the acute or chronic abscesses in the axilla are the result of suppurative processes of the neck, the clavicle, the scapula, the ribs, or the shoulder.

All incisions in the axilla are made in a longitudinal direction parallel to the anterior and posterior axillary folds. After dividing the skin and the fascia with the knife, one should bore his way into the abscess by means of some blunt instrument, carefully avoiding the vessels and the brachial plexus. For the removal of carcinomatous glands of the axilla in connection with amputation of the breast see vol. ii, § 137, page 748, and § 278, page 546.

Cicatricial contractions of the axilla are observed especially after extensive injuries and inflammations, particularly after burns. The upper arm is sometimes fixed to the body by firm cicatricial bands. The attempt should be made to prevent such cicatricial contractions, especially during the healing of extensive wounds and inflammations, by giving the arm a suitable position (as abducted as possible), by the transplantation of pedunculated flaps from the vicinity (chest), by skin-grafting, and later by stretching the cicatrices by means of massage and active and passive movements. Old and firm cicatrices attended by retraction of the upper arm should be divided and excised, and the defect in the skin made good by pedunculated cutaneous flaps or by skin-grafts.

§ 277. Inflammatory Processes of the Clavicle and the Scapula.—Periostitis and osteomyelitis of the clavicle occurs rather frequently—e. g., metastatically, in the form of acute infectious osteomyelitis and periostitis, after similar disease of the femur. It usually terminates in circumscribed necrosis. The chronic affections of the clavicle are either of tubercular or syphilitic nature. Syphilitic periostitis and osteomyelitis sometimes leads to very considerable enlargement of the clavicle, especially at the epiphyses, so that malignant tumours (sarcomata) are easily suggested. The treatment of syphilitic periostitis and

osteomyelitis of the clavicle should include a suitable local treatment and the use of the usual antisyphilitic remedies (mercury, iodide of potassium).

Tubercular periostitis and osteomyelitis of the clavicle in the form of caries is rather common. Its course is usually favourable, because, in consequence of the great power of regeneration possessed by the clavicle, even large defects are filled in. It is easy to scrape out diseased bone or extract sequestra by making a longitudinal incision along the clavicle and elevating the periosteum. The periosteum is usually so thickened that injury of the subclavian artery and vein can easily be avoided, even in complete excision of the clavicle (see also page 548).

Isolated and primary disease of the articulations of the clavicle is, generally speaking, rare, but they are more frequently affected secondarily after disease of the shaft or epiphysis of the clavicle, after affections of the neighbouring portions of the scapula, the shoulder joint, and the sternum, particularly in case of tubercular inflammation. Primary disease of the acromioclavicular joint alone is sometimes observed in the form of chronic serous arthritis or as arthritis deformans, with thickening of the end of the bone, among burden carriers and after injuries or dislocations of the acromial end of the clavicle. The acromial end of the clavicle may project upward permanently in consequence of loosening of the ligamentous apparatus or deformation of the articular surface. It is also a matter of practical importance that the acromial end of the clavicle sometimes becomes an independent "acromial bone." Inflammatory processes, deformations of the articular surface, and relaxation of the ligamentous apparatus with subluxation, occur somewhat more frequently at the sterno-clavicular joint. Tubercular and syphilitic affections are occasionally observed in both joints, terminating in suppuration and the formation of sequestra and fistulæ, which are treated according to general rules. Treatment of the subluxations is usually unnecessary.

Inflammatory Processes of the Scapula.—The various forms of periostitis and osteomyelitis are not infrequently observed after traumatisms; acute infectious osteomyelitis and periostitis occurs especially among children. The parts of the scapula that are most prominent are particularly likely to be affected after traumatisms—that is, the spine of the scapula, the acromion, and the coracoid process. The body of the scapula is less often involved. Tubercular periostitis and osteomyelitis is most frequently observed in the glenoid fossa and in the neck of the scapula, as a secondary affection following tubercular disease of the shoulder joint. Tubercular caries of the parts of the scapula that are covered by thick layers of muscle is often first recognised when gravitation abscesses appear at some point—e. g., in the axilla or on the back. For disease of the bursæ of the scapula the reader is referred to

page 536. We have already mentioned there that a creaking noise on moving the scapula may be due to inflammation of the bursa at the superior angle of the scapula, in the upper part of the serratus magnus muscle, or of the bursa subterrata in the loose connective tissue between the serratus magnus muscle and the side of the chest (Terrillon). In other cases the creaking or crackling of the scapula is caused by bony projections on the anterior surface of the scapula, at the superior angle of the same, and on the ribs, or by friction sounds in the shoulder joint.

All suppurative processes, especially those on the anterior surface of the scapula—that is, under the scapula—are often characterized by an extremely prolonged course, when the focus of the disease is not sufficiently opened up by an operation. Acute, deeply located abscesses under the scapula may be difficult to diagnosticate, and death from pyæmia and sepsis may occur in case the hidden pus focus is not recognised. In such cases, when there are inflammatory swelling and pain in the region of the scapula, an exploratory puncture should be made with a long, fine trocar, and if pus is found the abscess should be evacuated by a sufficiently long incision. It is sometimes necessary in such cases to resect the overlying scapula (see page 549).

§ 278. **Tumours in the Region of the Shoulder.**—Large sebaceous cysts, fibromata and lipomata, are sometimes observed in the soft parts about the shoulder (skin and subcutaneous cellular tissue), which not infrequently reach a great size. Diffuse lipomata are often found in the neighbourhood of the clavicle and the scapula and in the axilla (see vol. ii, § 96, page 557, Fig. 284). The extirpation of these tumours and that of the more deeply located subfacial lipomata is usually easy.

Angeiomata, especially cavernous tumours, are found most commonly in the axilla. The latter is also the favourite location of the different forms of tumours of the lymphatic glands, including malignant lymphomata (see Principles of Surgery, page 763), lympho-sarcomata and carcinomatous lymphomata, especially in carcinoma of the mammary gland. In every amputation of the breast for malignant tumour the axilla is laid open by a longitudinal incision and the fat and all the lymph glands are removed as completely as possible along the course of the large vessels, and behind the pectoralis major muscle as far as the infraclavicular and supraclavicular fossæ, even though no enlarged glands can be felt externally. The removal of carcinomatous glands that are firmly adherent to the sheaths of the large axillary vessels is the most difficult. The axillary vein often has to be tied in two places and the intervening portion excised. The operation should always be performed cautiously, use being made both of the knife and

scissors, or some blunt instrument and the fingers. Traction on the parts should be avoided, and it must not be forgotten that the entrance of air into the injured axillary and subclavian veins may cause immediate death. In order to expose the clavicular fossa sufficiently, one may resect the clavicle (Gussenbauer) and divide temporarily the pectoralis major. Injury of the brachial plexus, and especially of the circumflex and subscapular nerves, is to be avoided as far as possible (Küster).

Neuromata of the brachial plexus are rare. They may be enucleated, not infrequently, from the nerve sheath or the nerve itself, with preservation of its continuity.

Of tumours arising from the bone in the region of the shoulder I mention, in the first place, those at the up-

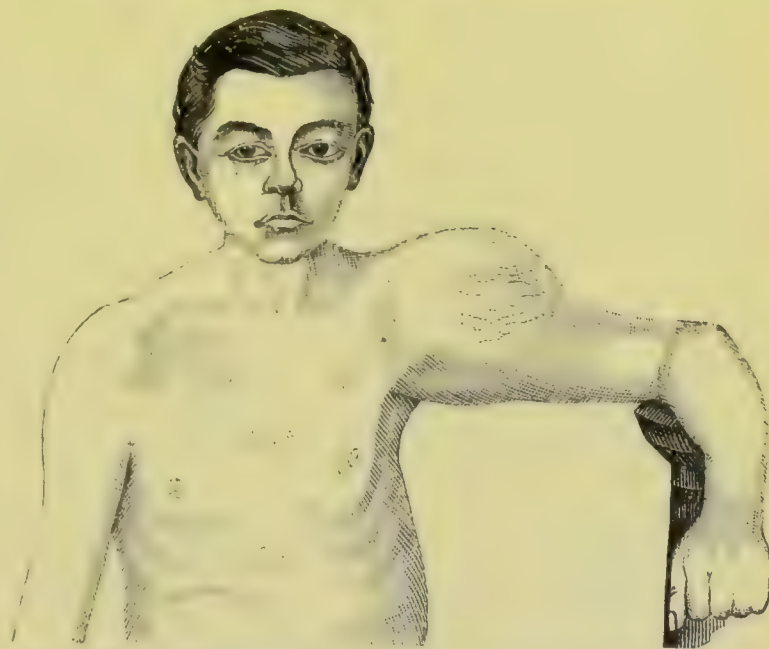


FIG. 661.—Osteosarcoma of the upper end of the humerus (Esmarch).

per end of the humerus (Fig. 661), especially the large vascular pulsating sarcomata originating in the periosteum or medulla, which may resemble an aneurism; also the chondromata, osteo-chondromata, and chondro-sarcomata, which likewise develop at the upper end of the humerus, and may reach a large size. If the tumours are still small, resection of the humerus may be sufficient, but its disarticulation, with removal of the scapula and clavicle, is almost always indicated, especially in case of sarcoma. The exostoses in the vicinity of the upper epiphysis of the humerus are much more favourable—e. g., the cartilaginous exostoses, which are removed with hammer and chisel. Such exostoses often occur among young people after separation of the epiphysis.

The formation of bone—i. e., circumscribed or more diffuse osteomata—in the deltoid muscle is observed especially among soldiers in consequence of continued drilling with a rifle, and from other repeated local traumatism. The new bone originates in the periosteum, and then grows into the deltoid muscle. We have to do mainly with a traumatic, chronic, ossifying periostitis, with gradual ossification of the deltoid muscle, which has been contused and undergone cicatricial change. So-called “riders’ bone,” in the adductor muscles of horsemen, has a similar origin.

The scapula is the seat often of enchondromata and osteomata, which are sometimes of considerable size. Sarcomata of the scapula are much larger, have a more unfavourable prognosis, and are to be removed only by extensive resections, or, it may be, by complete excision of the scapula. Gies, on the basis of eighty cases of partial and complete excision, advises the latter as soon as possible in cases of large malignant sarcoma (see page 549). Smaller benign enchondromata and osteomata can be removed sufficiently with hammer and chisel, with or without preservation of the underlying bone. In all tumours of the scapula and of the clavicle traumatism plays an important part. Osteochondromata and osteomata are not infrequently formed on the clavicle after fractures, and are then more correctly to be regarded as overproductions of callus. Sarcomata of the clavicle are rare. The tumours of the clavicle occasion comparatively early compression of the subclavian vein and the brachial plexus, with œdema of the upper extremity and disturbances of mobility and sensation. For this reason one should perform resection of the clavicle even in case of small tumours and of overproduction of callus. In case of malignant tumours the clavicle should be completely excised as early as possible, as the function of the arm is usually not disturbed thereby, even when no new growth of bone takes place.

Complete excision of the scapula, with resection of the clavicle and disarticulation of the humerus, has been successfully performed for large tumours in the region of the shoulder. Of twenty-six such cases, seventeen recovered and seven died (Grisson). Doll collected sixty-five cases of excision of the scapula, with and without removal of the arm. Sixteen patients died during or soon after the operation; there were twenty-two recurrences and twenty-seven cures, only eleven of which, however, proved permanent.

§ 279. **Resection and Excision of the Clavicle and the Scapula.**—Partial or complete resection of the clavicle is indicated especially for necrosis or new growths, also for tumours in the region of the clavicle—e. g., when there are masses of carcinomatous or sarcomatous lymph glands in the supraclavicular and infraclavicular fossæ, and, finally, to facilitate ligation of the subclavian and innominate arteries, after Bardenheuer. Subperiosteal resections of the clavicle are very easy. The skin and periosteum are divided in the longitudinal direction of the clavicle, the periosteum is separated from the latter on all sides, and then a piece of bone of the proper size resected with the chain saw, or the entire bone excised at the articulations with the sternum and the acromion. It is also a good plan in complete excision of the clavicle to saw the bone through in the middle and then to disarticulate the

halves at the articulations. The operation is more difficult when the periosteum can not be preserved. In other respects, however, it is essentially the same as in subperiosteal resection. Injury of the subclavian artery and vein is especially to be guarded against. The restoration of the clavicle after subperiosteal resection is sometimes very complete. But even when no new growth of bone takes place after complete extirpation of the clavicle the function of the arm is usually not disturbed.

In all resections of the scapula, those parts which are of special importance for the function of the arm—viz., the glenoid fossa, the acromion, and the coracoid process—are to be preserved as far as possible. In all cases in which the periosteum can be preserved the operation is performed subperiosteally. Even after very extensive resections of the scapula striking regeneration of the bone has been observed on the part of the periosteum and the medulla that are left behind (Hashimoto and others). During the operation the patient lies on the sound side with the arm drawn forward.

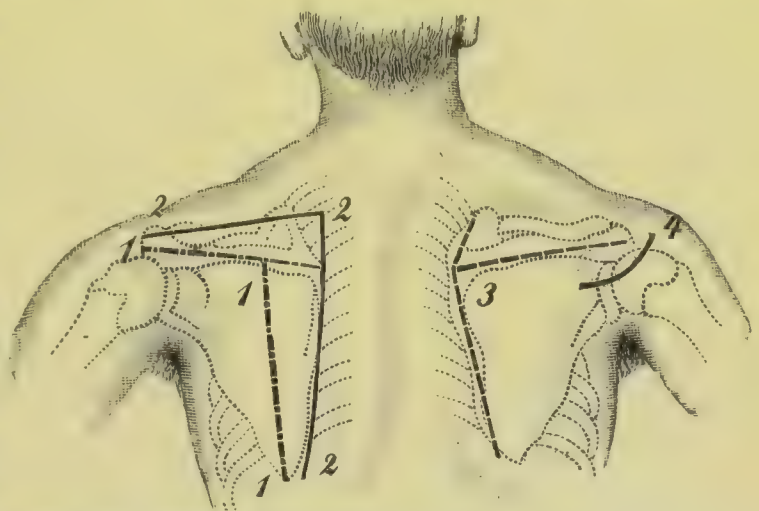


FIG. 662.—Excision of the scapula: 1, after Syme; 2, after Langenbeck; 3, after Ollier; 4, incision for resection of the glenoid fossa of the scapula.

Excision of the Scapula is performed either with or without preservation of the periosteum and the covering of muscles. Of the different methods of performing the operation I mention especially those of Syme, Langenbeck, and Ollier (Fig. 662). Sedillot and Chassaignac formed a simple semicircular flap with its base above. Velpeau operates in much the same way as Ollier (Fig. 662, 3).

If it is desired to remove the scapula without preserving the muscles and the periosteum, the skin incisions after Syme or Langenbeck are the best (Fig. 662). After the cutaneous flaps have been dissected up, the insertions of the rhomboid and the levator-anguli-scapulæ muscles are separated from the inner border of the scapula, the trapezius and deltoid muscles from the spine and the acromion, the omohyoid muscle from the upper border, and the teres minor and major muscles from the outer border and the lower angle. The inner border of the scapula is then lifted from the thorax, and the bone is detached

from the serratus magnus muscle which lies beneath it and from the subscapularis. The capsule of the shoulder joint is now opened by a horse-shoe-shaped incision above the head of the humerus, the insertions of the supraspinatus and infraspinatus muscles are severed at the greater tuberosity, the acromio-clavicular joint is opened, the scapula is rotated outward, the remainder of the capsule is divided from below and the tendons of the biceps and the triceps muscles are severed at the border of the glenoid cavity, and, finally, the pectoralis minor and the coracobrachialis are cut away at the coracoid process. This completes the excision of the scapula. Of the vessels, the posterior scapular artery is tied at the upper and inner angle of the scapula, the suprascapular artery on the transverse ligament, and the dorsalis scapulæ at the lower border of the triceps muscle as well as any muscular branches. In order to fix the arm more securely after complete extirpation of the scapula, one may unite the head of the humerus with the inferior surface of the acromial end of the clavicle by means of a few sutures. By suturing the remains of the capsule to the muscles a sort of nearthrosis may be formed. The wound is covered by cutaneous flaps, sutures are inserted, the wound is drained at its most dependent part, and a large aseptic, protective dressing applied.

The incision after Ollier is the best one for complete subperiosteal extirpation of the scapula (Figs. 662, 3). Through the incisions in the skin the soft parts and the periosteum are detached from the bone on all sides with the knife and periosteal elevator, first in the infraspinous and then in the supraspinous fossa. The scapula is then likewise separated from the periosteum and the soft parts on its under surface, beginning at the lower angle, the bone being drawn outward and upward. The capsule of the shoulder joint is finally opened from below and the insertions of the muscles on the glenoid fossa, the greater and lesser tuberosities, and the coracoid process are severed. It is simpler to saw off the coracoid process.

Complete extirpation of the scapula with resection of the clavicle and disarticulation of the arm—for tumours, for example—may be performed by first disarticulating the arm after ligation of the axillary vessels (see also § 281, page 555), then dividing the clavicle with the chain saw, and finally excising the scapula as described above. One may also operate according to Paul Berger's method: 1. An incision is made along the clavicle, from a point two and a half centimetres outward from the sterno-clavicular articulation to the acromial end, followed by subperiosteal resection of the middle part of the clavicle. 2. The subclavius muscle is severed, the cephalic vein and the acromio-thoracic artery are tied, the subclavian artery and vein are then ex-

posed, ligated in two places and severed between the ligatures, and the suprascapular vessels are tied and divided in a similar manner. The posterior scapular artery is ligated at the close of the operation. 3. Two cutaneous flaps are formed—a smaller one in front and below (incision from the middle of the clavicular incision to the inner side of the arm and as far as the lower angle of the scapula), and a longer one behind and above (incision downward from the outer end of the first incision as far as the lower angle of the scapula). Then follows enucleation of the arm with the scapula. Bergmann operates in a similar manner, and out of fourteen cases lost only one soon after the operation. He first ties the subclavian artery on the outer side of the scalenus anticus muscle, saws through the clavicle, ties the subclavian vein, and divides the brachial plexus; a thick anterior and posterior flap consisting of skin and muscle is then formed, as in Berger's method. The muscles passing from the scapula to the arm as well as the deltoid should be removed. Complete extirpation of the shoulder with the arm is indicated, especially for sarcoma of the humerus. Recurrences are more surely avoided in this way, so that the patient has a better chance of permanent cure than by mere disarticulation of the humerus.

Partial resections of the scapula are likewise performed with or without preservation of the periosteum and the covering of muscles. The incision is made according to the nature of the case. Resection or amputation of the scapula with preservation of its neck is performed essentially in accordance with the rules for complete extirpation. The bone is then sawn off at the neck of the scapula without opening the shoulder joint. The acromion and the coracoid process are likewise sawn through or excised from the soft parts. Other partial resections—e. g., that of the spine of the scapula, of an angle of the scapula, or of the acromion—are performed in the same general way. The parts are exposed sufficiently by proper skin incisions and then removed with the hammer and chisel.

If the glenoid cavity of the scapula is alone to be resected—e. g., on account of a gunshot fracture—one makes either a curved incision from the spine of the scapula to the posterior surface of the head of the humerus, as shown in Fig. 662, 4, or Esmarch's incision (Fig. 663). In the latter case a curved incision encircles the posterior border of the

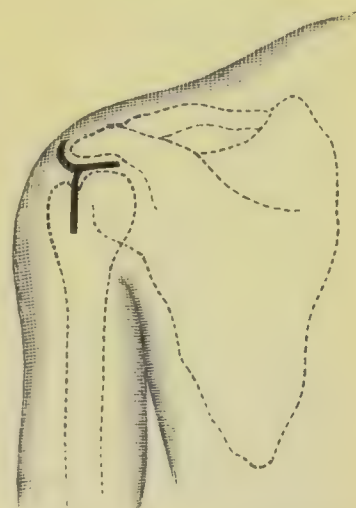


FIG. 663.—Resection of the glenoid fossa of the scapula (Esmarch).

acromion and divides the fibres of the deltoid muscle. An incision is then made downward from the middle of the curved incision through the skin, the deltoid muscle, and the articular capsule, between the tendons of the supraspinatus and infraspinatus muscles, as far as the middle of the greater tuberosity. After the soft parts have been drawn apart by means of sharp retractors, the tendon of the long head of the biceps is detached from the border of the glenoid process, and the capsule, together with the periosteum of the neck of the scapula, is so far detached on all sides that one can remove with a metacarpal saw the glenoid fossa or the fragments of the bone which may have been fractured. The after-treatment is the same as that following resection of the shoulder joint (see page 554).

§ 280. **Resection of the Shoulder Joint.**—Two methods are especially suited for this operation—viz., a longitudinal incision from the acro-

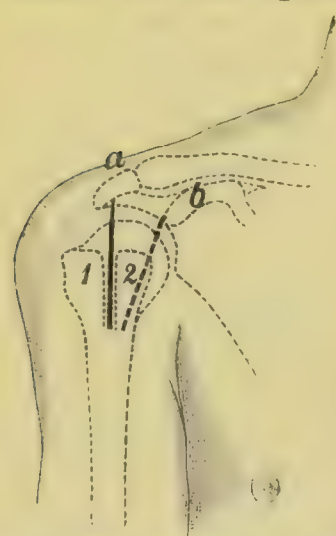


FIG. 664.—Resection of the shoulder joint: *a*, after Langenbeck; *b*, after Ollier and Hueter; 1 and 2, greater and lesser tuberosities.

mion downward through the middle of the deltoid muscle, after Langenbeck (Fig. 664, *a*), and the longitudinal incision recommended by Ollier and Hueter, from the outer side of the coracoid process downward (Fig. 664, *b*). The latter method decidedly deserves the preference, because the deltoid muscle is much less injured by this incision, and this is of great importance in its bearing upon the functional result of the operation. The incision lies as far removed as possible from that point where the posterior circumflex artery and the circumflex nerve enter the deltoid muscle from behind. Atrophy and disturbances of innervation of the deltoid muscle are therefore by no means so much to be feared as from the use of Langenbeck's method. The

tendon of the biceps muscle can also be lifted from its groove with great ease. I therefore use the method of Ollier and Hueter almost exclusively.

The patient lies in a semi-recumbent position. The shoulder joint is brought close to the edge of the table, so that the arm hangs down freely. An assistant grasps the arm, which is flexed at the elbow joint, abducts it somewhat, and rotates it outward, so that the external condyle points directly outward. In this way one reaches most easily the bicipital groove with the tendon of the biceps muscle. The above-mentioned skin incision begins at the outer side of the coracoid process upon the coraco-acromial ligament and runs downward in the direction of the fibres of the deltoid muscle to a point below the lesser

tuberosity. After division of the skin and the deltoid muscle the edges of the wound are drawn apart with sharp retractors, and the bicipital groove usually appears at once with the sheath of the biceps tendon. The sheath is divided in its entire extent upon a grooved director, and farther up the capsule is opened in its entire length as far as the acromion. The biceps tendon is lifted from the groove and drawn outward with a blunt hook. The further course in subperiosteal resection of the joint consists in detaching the muscular insertions from the greater and lesser tuberosities, together with the periosteum, by means of the knife and periosteal elevator, working from the incision in the capsule, so that both halves of the capsule remain connected with the muscular insertions and the periosteum. To accomplish this the periosteum is first divided through the incision in the capsule at the inner border of the bicipital groove and separated, together with the insertion of the subscapularis muscle, from the lesser tuberosity, partly by the use of a periosteal elevator and partly with a knife, while the upper arm is rotated outward more and more. The arm is then rotated inward, the tendon of the biceps muscle retracted inward, and in the same way the periosteum, together with the insertions of the supraspinatus, the infraspinatus, and the teres minor muscles, is separated from the greater tuberosity. The head of the bone is then forced out of the wound and divided with a chain saw. This subperiosteal or subcapsular resection is always to be preferred to the "open method." The best results are obtained by resecting the head of the bone through the upper part of the tuberosities. The periosteum is detached but very little in such cases. Here also the insertions of the muscles must not be simply cut away from the bone, but must be detached from it only as far as is requisite and left connected with the bone or the periosteum below. The more of the humerus one is compelled to remove, the greater the danger of a loose joint.

The "open method" of resection is, to be sure, much simpler, but it is very undesirable for the reason that the insertions of the muscles are simply cut off at the tuberosities. After the tendon of the biceps muscle has been lifted from the bicipital groove the upper end of the humerus is enucleated on all sides from the soft parts and then sawn off. As has been said, the most important principle in subcapsular or subperiosteal resection is that the muscular insertions are not simply cut away from the bone, but remain connected with the capsule, the periosteum, and the bone.

The glenoid fossa of the scapula is almost always preserved after resection of the head of the humerus. Should it be necessary to remove parts of this likewise, it is done either with a sharp spoon—e. g.,

in case of caries—or certain parts are bitten off successively with Luer's bone-cutting forceps.

Posterior incisions may be made sometimes, when, for example, it is desired to remove a ball or splinters from the posterior part of the head of the humerus. For such partial resections Ollier recommends that the deltoid muscle be detached posteriorly with the formation of a triangular or quadrangular flap with its base below, or one may simply make an incision about the acromion. I have repeatedly tried posterior incisions on the cadaver, but found them undesirable. Special care must be taken not to injure the circumflex nerve.

Resection of the articular process of the scapula has already been described on page 551.

After the operation is completed, drainage and suture of the wound follow and an aseptic dressing is then applied, the humerus being suitably placed and well supported. A thick aseptic pad of mull, a moss-pillow, wood wool, or paper wool is placed in the axilla, in order that the arm may not sink inward. The shoulder, the upper arm, and the elbow joint, which is flexed at right angles, are covered with a large pad of dressing similar in size, and the arm is fixed upon the thorax. It is necessary to keep the arm well supported, and this is most simply accomplished by means of the protective dressing which has just been described, which includes the elbow joint flexed at right angles. The after-treatment following healing of the wound consists in massage, in active and passive movements, and in the use of electricity. Surprisingly good results are sometimes secured, so that the arm can even be raised to the perpendicular. If a loose joint results, a suitable brace is employed or arthrodesis performed (see § 273, page 535). With the aid of the scapula patients possess, in spite of ankylosis of the shoulder joint, a mobility of the arm which is sometimes extremely satisfactory, and their condition is in so far decidedly improved that they have neither pain nor a diseased joint. The amount of shortening of the upper arm depends essentially upon the extent of the disease—that is, upon whether or not in young persons the epiphyseal line can be preserved.

§ 281. **Amputation at the Shoulder.**—Esmarch's bloodless method of operating is hardly practicable at the shoulder joint. The subclavian artery and vein may be compressed above the clavicle, after Keen, by means of an India-rubber pad, which is secured by an elastic bandage in the form of a spica passing through the axilla of the opposite side and over the perinæum. The hæmorrhage is best controlled in amputation at the shoulder by performing a high amputation of the

upper arm, ligating the brachial artery and the other vessels in the amputation stump, and then disarticulating the head subperiosteally, it may be, by means of a longitudinal incision downward from the acromion. The method is as follows:

After applying Esmarch's tourniquet (see Fig. 665) the arm is abducted and all the soft parts are divided down to the bone in the vicin-

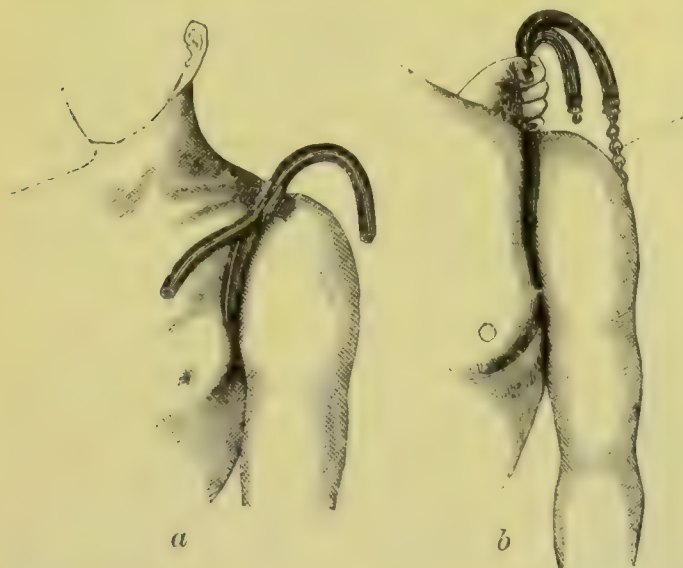


FIG. 665.—Esmarch's tourniquet applied to the shoulder for high amputation of the upper arm.

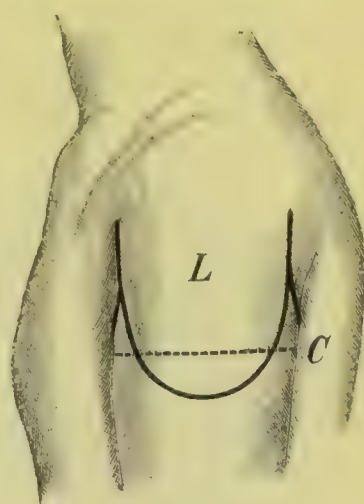


FIG. 666.—Disarticulation of the shoulder: *C*, circular incision (high amputation of the arm); *L*, flap incision.

ity of the lower boundary of the deltoid muscle by a circular incision (Fig. 666, *C*). The bone is then sawn through and all the gaping vessels ligated (brachial artery and vein, superior and inferior profunda, and both circumflex arteries). After removal of the tourniquet all the soft parts are divided to the bone by a longitudinal incision downward from the acromion as far as the circular cut. The lower end of the stump of the bone is then grasped with a bone forceps, the edges of the wound are held apart with retractors, and the bone is disarticulated from the joint, the periosteum being elevated, if necessary, from the entire stump of the bone. The brachial plexus is drawn forward with forceps and cut off as short as possible with scissors. In order to obtain a well-rounded stump it is a good plan to remove the acromion and a portion of the coracoid process with a chisel or a metacarpal saw. The appearance of the wound is shown in Fig. 667. The wound is finally irrigated, drained, and sutured, and dressings are applied.

The disarticulation which has just been described may also be performed by first making the longitudinal incision, after Dumreicher and Bergmann, from the anterior border of the acromion, or, as in resection of the humerus, midway between the coracoid process and the acromion downward as far as the lower border of the deltoid muscle.

This incision goes down to the bone and two divergent skin incisions are made outward and inward from the lower end of the longitudinal incision. The capsule and the muscular insertions are now detached close to the bone, the head of the humerus is displaced from its cavity, a long amputation knife is passed downward behind the humerus and

close to the bone, the axillary artery is compressed in the wound or ligated, and the amputation knife is drawn out through the two divergent skin incisions. This incision is especially to be recommended when one is in doubt whether resection or amputation ought to be performed.

If it is necessary, on account of existing defects in the soft parts, for example, to employ a flap amputation, the formation of an anterior broad U-shaped flap (Fig. 666, L), with a small posterior circular incision, is to be recommended. The U-shaped skin incision begins at the coracoid process and ends behind at the base of the acromion or the outer part

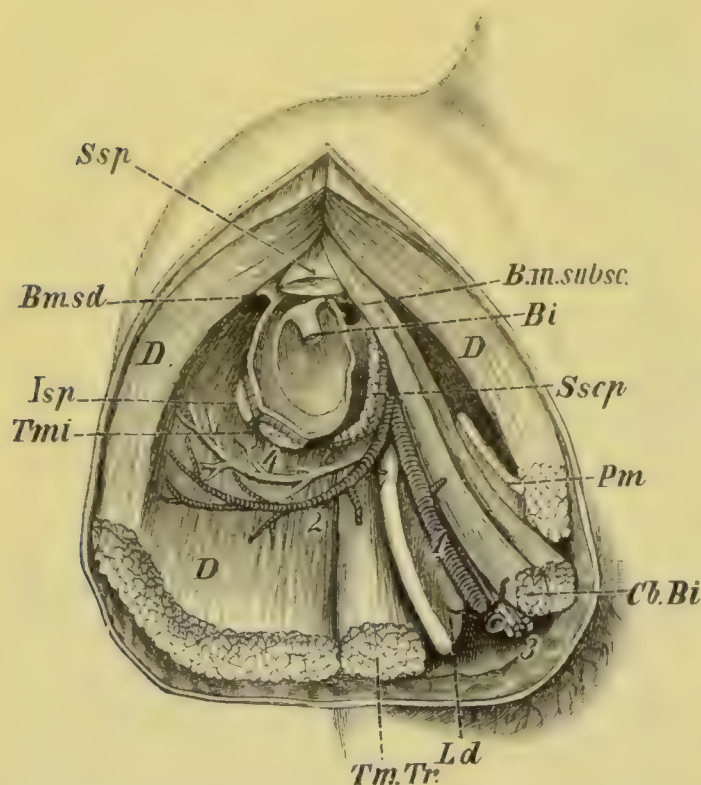


FIG. 667.—Disarticulation at the shoulder: *Ssp*, supra-spinatus muscle; *Bm. sd*, subdeltoid mucous bursa; *Isp*, infraspinatus muscle; *Tmi*, teres minor; *D*, deltoid; *Tm* and *Tr*, teres major and long head of the triceps; *Ld*, latissimus dorsi; *Cb* and *Bi*, coracobrachialis and short head of the biceps; *Pm*, pectoralis major; *Sscp*, tendon of the subscapularis; 1, brachial artery and vein; 2, posterior circumflex artery; 3, brachial plexus; 4, circumflex nerve (Rotter).

of the spine of the scapula. The anterior flap is dissected up from the bone and held upward, the shoulder joint is opened, and the long tendon of the biceps muscle is severed at the same time. The insertions of the muscles on the tuberosities are divided, the arm being rotated inward and outward, the head of the humerus is displaced from its cavity, a large amputation knife is passed downward behind the humerus, as above, the axillary artery and vein compressed or ligated in the wound, and then the remaining soft parts in the axilla cut through from without or from within with a large amputation knife. In this flap method one may also expose and ligate the axillary artery and vein at the outset in the upper part of the incision (see vol. ii, § 90, page 520, Fig. 278, 3).

Amputation at the shoulder with removal of the scapula and clavicle has been described on page 550. It is indicated especially in case of malignant tumours of the upper arm, in order to be able to remove the entire upper extremity as far as possible from the focus of disease and to give the patient a better prospect of a permanent cure.

For the general technique of bandaging the shoulder aside from that already described, the reader is referred to Principles of Surgery, §§ 50-55.

CHAPTER XXX.

INJURIES AND DISEASES OF THE UPPER ARM AND THE ELBOW JOINT.

Fractures of the Shaft of the Humerus.—Injuries of the soft parts of the upper arm.—Ruptures of the muscles and tendons.—Dislocation of the long tendon of the biceps.—Injuries of the nerves, paralysis of the musculo-spiral nerve, of the musculo-cutaneous nerve, etc.—Wounds of the brachial artery.—Ligation of the brachial artery.—Aneurisms.—Inflammatory processes in the upper arm (soft parts and bone).—Myositis ossificans.—Necrosis of the humerus.—Sequestrotomy.—Tumours.—Amputation of the upper arm.

Injuries and Diseases in the Region of the Elbow.—Injuries and diseases of the soft parts (skin, bursæ, vessels, nerves).—Contusions.—Skin defects in the region of the elbow.—Cicatricial contractions.—Injuries and inflammations of the bursæ.—Injuries of the nerves.—Dislocation of the ulnar nerve.—Wounds of the brachial artery at the bend of the elbow.—Aneurisms.—Ligation of the brachial artery at the elbow.—Venesection.—Transfusion and Infusion.—Fractures of the lower end of the humerus.—Fractures of the upper ends of the ulna and radius.—Dislocations of the elbow joint.—Injuries and inflammations of the elbow joint.—Tumours.—Contraction and ankylosis of the elbow joint.—Cubitus varus and valgus.—Resection of the elbow joint.—Amputation at the elbow.—Technique of bandaging the upper arm and the elbow joint (see Principles of Surgery, §§ 50–55).

§ 282. **Fractures of the Shaft of the Humerus.**—The rather frequent fractures of the shaft of the humerus arise usually from direct violence, less often from that which is indirect—e. g., from a fall upon the elbow or the hand. Fractures are sometimes occasioned by muscular action—e. g., in an epileptic attack, in throwing a heavy object, or in striking through the air. In the latter cases the bone usually breaks below the insertion of the deltoid muscle. Otherwise the location of the fracture varies. It is found sometimes in the upper third and sometimes in the middle or lower third. The line of fracture is usually oblique in complete fractures. The displacement of the fragments depends mainly upon the direction in which the violence is inflicted, upon the course of the line of fracture, and upon its location. Spiral fractures of the humerus (see Principles of Surgery, page 574, Figs. 334 and 335) are rare, and longitudinal fractures are much rarer still. The latter may extend through the entire length of the bone, from the upper to the lower articular extremity. Krönlein

observed a longitudinal fracture of the humerus resulting from violent muscular action. Most of the so-called longitudinal fractures are those with a very oblique line of fracture. Double fractures sometimes occur, so that a piece is broken out of the humerus. Compound fractures of the humerus present no special peculiarities. The nerves and the brachial artery may easily be injured by sharp fragments in comminuted fractures. Among injuries of the soft parts, those of the brachial artery and the nerves are especially to be considered. The musculo-spiral nerve may also be paralyzed after union of the fracture in consequence of compression from overproduction of callus, which may completely inclose it (W. Busch, Ollier, Bardeleben, Bardenheuer).

The symptoms of fracture of the shaft of the humerus are very characteristic, so that the diagnosis is easy. The upper arm is powerless and the abnormal mobility and the deformity are particularly striking when the patient tries to raise the arm. The latter then bends in at the site of the fracture. Likewise, when the attempt is made to abduct the arm from the side the angular deformity is visible at the point of fracture.

Crepitus can usually be easily demonstrated by movement of the fragments upon one another. The axis of the bone deviates, as a rule—that is, the external condyle of the humerus, the greater tuberosity, and the acromion do not lie in a straight line, as under normal conditions. The amount of shortening of

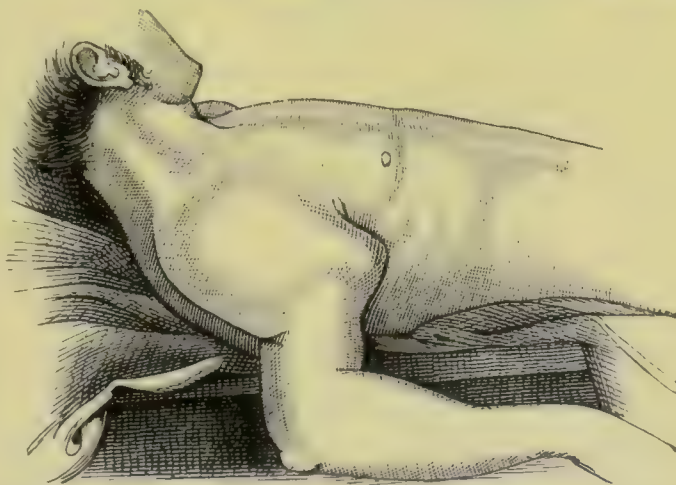


FIG. 668.—Pseudarthrosis of the humerus of twelve years' duration in a man fifty-three years old.

the upper arm depends upon the character of the displacement of the fragments. One should always examine the patient carefully with reference to any possible injury of the arteries or the nerves. A large hæmatoma, circulatory disturbances, absence of the radial pulse, discoloration and gangrene of the skin, indicate injury of the brachial artery. Sensory and motor disturbances accompany injuries of the nerves.

The prognosis of fractures of the shaft of the humerus is usually favourable. Bony union takes place, as a rule, in from thirty to forty days. Pseudarthrosis occurs, however, rather frequently (Fig. 668, after Heine). Of four hundred and seventy-eight pseudarthroses, one hundred and sixty-five, according to Gurlt, affected the humerus. The causes of this so fre-

quent occurrence of pseudarthrosis are the interposition of portions of the muscles between the fragments, defective immobilization of the fragments by the splint, necrosis of the ends of the fragments, constitutional conditions, and, above all, the fact that the lower fragment is drawn away from the upper one by the weight of the forearm. The prognosis of compound fractures, with wounds of the arteries and the nerves and with fissures running into the shoulder joint or the elbow joint, and that of complete longitudinal fractures, is the most unfavourable. In the case of longitudinal fracture of the humerus which Krönlein observed there resulted ankylosis of the shoulder and the elbow in consequence of inflammation of these joints.

Treatment of Fractures of the Shaft of the Humerus.—After the reduction of any existing displacement—e. g., by extension and counter-extension, so that the external condyle of the humerus is in line with the greater tuberosity and the acromion—the splint is so applied in simple fractures as to include the shoulder and the elbow. Splints similar to those used in fractures of the surgical neck of the humerus are very serviceable—such as are represented, for example, in Figs. 636, 637, and 638, pages 512, 513. In using splints made of pasteboard, felt, or cellulose, which are softened in hot water, a flannel bandage is



FIG. 669.—Plaster splint about the shoulder, thorax, and arm for fractures of the upper end of the humerus.

put on, and then the outer splint, reaching to the wrist joint, is applied around the arm, which is flexed at right angles at the elbow, and an inner splint reaching only to the internal condyle of the humerus. The latter may be dispensed with, and instead a pad of wadding or a triangular cushion is placed in the axilla, and the arm is fastened to the chest by a plaster-of-Paris dressing which includes the elbow joint flexed at right angles. One may also lay the arm, flexed at right angles at the elbow joint, upon the padded thorax and then fix it by plaster-of-Paris bandages which encircle the thorax, the shoulder, and the elbow (Fig. 669). For the extension dressings of Lossen, Hofmokl, or Hamilton, see *Principles of Surgery*, pages 227 and 228, Figs. 211–213. The treatment of

compound fractures conforms to generally accepted rules (see *Principles of Surgery*, page 597). The fragments should here, if necessary, be wired or nailed. Paralysis of the musculo-spiral nerve resulting from the pressure of a hypertrophic callus is cured by removing the callus with hammer and chisel. Paralysis of this nerve resulting from

traumatism usually demands merely the laying free of the nerve. The prognosis in such cases is very favourable. Murray collected thirty-eight cases of paralysis of the musculo-spiral nerve which were operated upon. In nearly all these cases the function of the nerve was restored. In thirty-four cases exposure of the nerve was alone requisite, and in three cases it was necessary to perform neurorrhaphy. Pseudarthroses are best treated by an operation consisting in freshening and suturing or nailing together the ends of the bones. The end of one fragment may also be made pointed and inserted into the medullary cavity of the other (see also Principles of Surgery, page 603).

§ 283. **Injuries of the Soft Parts of the Upper Arm.**—Among injuries of the soft parts of the upper arm we mention, first, dislocation and rupture of the long tendon of the biceps muscle, which very seldom occur alone, but are observed more frequently in connection with dislocation of the shoulder and fracture of the upper end of the humerus—e. g., in the region of the tuberosities. Dislocation of the tendon of the biceps muscle from the bicipital groove, which has as yet rarely been diagnosticated in the living subject, is characterized by great pain, by effusion of blood and crepitus in the bicipital groove, by feeling a cord which slips to and fro, and by interference with the extension of the forearm. These dislocations of the tendon of the biceps are treated by immobilizing the arm after reposition of the tendon, and then, later, by massage and passive movements.

In case of rupture of the tendon of the biceps muscle, which occurs most frequently at the upper border of the glenoid fossa in connection with dislocations of the shoulder and fractures of the upper end of the humerus, the forearm can only be flexed in a weak and imperfect way. The biceps muscle does not contract. Ruptures of the biceps muscle are more common than those of its tendon. Flexion of the arm is interfered with here also, and in case of deep tears one distinctly feels at the point of rupture a gap in the muscle. Healing usually follows with the formation of a fibrous cicatrix without permanent functional disturbance. The latter is to be feared only when the divided ends of the muscle separate too far from one another and are not united by suture.

Of other ruptures of muscles and tearing away of the insertions I mention particularly ruptures of the deltoid, the triceps, the pectoralis major, and the coraco-brachialis, of the short head of the biceps, of the external rotators (the supraspinatus, infraspinatus, and teres minor muscles), and the internal rotators (the subscapular and teres major muscles). The most severe injuries of the muscles are caused by machinery; but even when the muscles are badly torn, complete healing may take place.

Ruptures of muscles and tendons—in case functional disturbances are to be feared or, in cases of long standing, already exist—are to be treated by aseptic suture of the muscles or tendons (see Principles of



FIG. 670.—Partial circular defect of the muscles of the upper arm in a factory girl twenty-two years old which resulted, at the age of five, from supuration following an insect bite. No impairment of function (Uhde).

Surgery, page 468). In case of defects in the muscles, pedunculated flaps may be cut from the ends of the same and sutured into the defect. Transplantation of muscle from animals is usually unsuccessful. The case shown in Fig. 670 illustrates very well the fact that even extensive defects in the muscles may be so completely replaced by cicatricial tissue that the contraction of the muscles is not disturbed by the intervening cicatrix.

Among paralyses of the nerves in the upper arm, those of the musculo-spiral and the musculo-cutaneous are especially to be considered. Paralysis of the circumflex nerve and other nerves of the shoulder has been described on pages 531–533. Regarding paralysis of the median and ulnar nerves, which do not supply the muscles of the upper arm proper, see Surgery of the Forearm and the Hand, § 295, page 603 ff.

For the treatment of injuries and paralysis of the nerves, see § 295, page 603 (Surgery of the Forearm and the Hand), and Principles of Surgery, page 453 ff.

The musculo-spiral nerve is exposed to numerous injuries in consequence of its unfavourable course in the upper arm. It leaves the axilla between the long and the inner heads of the triceps muscle, passes to the posterior surface of the humerus, then runs along the outer side of the humerus about to the boundary between the middle and lower thirds of the latter, and passes in front of the external condyle and the capitulum of the radius between the brachialis anticus and the supinator longus muscles. The musculo-spiral nerve supplies in the upper arm the triceps and the external portion of the brachialis anticus muscle, so that these muscles are paralyzed in case of paralysis of this nerve high up. We have already mentioned on page 560 the paralysis of the musculo-spiral nerve caused by overproduction of callus after fracture of the humerus. One sometimes observes paralysis of this nerve, which is usually of short duration, resulting from pressure—e. g., when, in long-continued narcosis or in sleep, the upper arm, which lies behind the head, has been compressed by the latter. We shall describe more

in detail in § 295 the characteristic functional disturbances of the forearm and the hand in connection with paralysis of the musculo-spiral nerve. The treatment of the paralysis conforms to general principles. Traumatic paralyses are cured usually by exposing the involved part of the nerve (suture, removal of any callus that causes pressure after fractures, etc. See also page 560).

The musculo-cutaneous nerve supplies the biceps and the coracobrachialis muscles and the inner portion of the brachialis anticus. The external portion of the latter is supplied by the musculo-spiral, as has just been stated. Erb saw a case of very rare isolated paralysis of the musculo-cutaneous nerve in consequence of the extirpation of a tumour in the supraclavicular fossa. The biceps and the inner portion of the brachialis anticus were paralyzed, and showed pronounced signs of degeneration. The characteristic slight anæsthesia also on the radial border of the forearm was present. The forearm was held in slight flexion, and further flexion was possible to a certain degree by means of the supinator longus and the external portion of the brachialis anticus muscles. The treatment is the same as that which was briefly stated above in connection with paralysis of the musculo-spiral nerve.

Injuries of the brachial artery are observed not infrequently—e. g., in connection with dislocations of the elbow joint and fractures, especially gunshot fractures; also from a puncture, a stab or a cut, or, finally, from contusions, partial or complete subcutaneous rupture, etc. The median nerve is not infrequently injured at the same time. Death from hæmorrhage may ensue quickly, in case of open, complete division of the artery, before medical aid can be secured. A subcutaneous extravasation of blood, a hæmatoma, is formed in case of punctured wounds and subcutaneous injuries, by which the hæmorrhage is arrested temporarily or permanently. A true aneurism then develops later, it may be, from the hæmatoma or the so-called traumatic aneurism. The subcutaneous ruptures of the artery have a more unfavourable prognosis, because the formation of a collateral circulation is made difficult in consequence of the pressure of the extravasated blood and the congestion of the veins. An ischæmic condition of the arm sometimes ensues with striking rapidity. Secondary hæmorrhages are especially to be feared in case of contusion. Even when there is complete division of the artery, spontaneous healing has been observed.

The treatment of every injury of the brachial artery consists in ligation of both ends of the artery in the wound. Any lateral branches that leave the injured part of the vessel must also be carefully tied. In case of subcutaneous rupture of the brachial artery the extravasa-

tion of blood is to be removed as soon as possible after free incision, and the ends of the vessel are ligated proximally and distally. The hæmorrhage is arrested temporarily by digital compression in the wound or above it in the bicipital groove, also by constriction of the arm by means of a firmly tied handkerchief, a towel, or a rubber tourniquet.

Ligation of the Brachial Artery.—The artery can be tied at any point along the inner border of the biceps muscle. The arm is abducted at right angles from the trunk, and the inner border of the biceps muscle is exposed by a longitudinal incision about six centimetres in length. The basilic vein and the internal cutaneous nerves are best avoided by making the incision upon the inner border of the biceps muscle. The muscle is then retracted outward, and the median nerve and the artery immediately appear. The median nerve lies upon the brachial artery in the middle of the arm. Higher up it lies to the outer side of the artery, and farther down it lies on its inner side. Beginners often mistake the basilic vein and the internal cutaneous nerve for the brachial artery and the median nerve. The brachial artery is accompanied by two veins. If it is noticeably small, a high division of the same must be thought of. In that case the second arterial trunk usually lies alongside the first.

Aneurisms of the brachial artery are more rare in the upper arm than at the elbow (see page 570). Their treatment by digital or instrumental compression is especially successful. Twenty-nine out of thirty-two cases were cured, according to G. Fischer, by digital compression above the aneurism. If this does not accomplish the purpose, ligation of the artery is to be recommended, the best way being to tie it above and below the sac, lay open the latter, and, it may be, ligate the nearest collateral branch (Kocher). See also *Principles of Surgery*, page 532 ff (Aneurisms).

§ 284. **Inflammatory Processes in the Upper Arm.**—Superficial cellulitis and deep phlegmon of the upper arm occur especially after injuries of the fingers with secondary lymphangitis and phlebitis. They extend by preference along the inner side of the arm.

Acute and chronic inflammations of the lymphatic glands also attack by preference the glands of the inner side of the arm. In syphilis and tubercular processes the epitrochlear glands are usually diseased.

Inflammatory processes are occasionally observed in the biceps, the brachialis anticus, and the triceps—e. g., after injuries or as gummatous myositis, terminating in the formation of indurations. Myositis ossificans also occasionally attacks the muscles of the upper arm (Fig. 671). Bone is sometimes formed in the biceps muscle in consequence

of repeated traumatism—e. g., from drilling with the rifle. The bone formation originates here in the periosteum, and we have to do with a

traumatic ossifying periostitis which extends into the muscle. Düms saw a reflex neurosis, consequent upon the formation of bone in the deltoid muscle, which consisted in trembling movements and pain in the entire arm reaching to the finger tips. It only appeared upon

pressure of the rifle against the ossified portion of the muscle, and ceased upon the extirpation of the latter.

In rare cases free osteomata of unknown etiology have been observed lying in the muscle and not connected with the bone. Progressive multiple myositis ossificans is a peculiar affection which usually begins in childhood and gradually attacks a large number of muscles—e. g., of the back, the chest, the arms, the

jaws, etc. We have probably to do here with a congenital anomaly of development. The specimen shown in Fig. 671 may have been taken from a case of this sort.

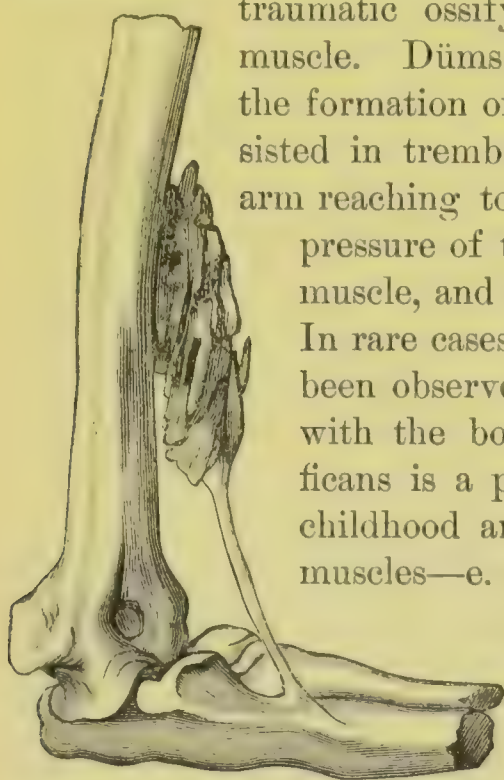


FIG. 671.—Ossification of the brachialis anticus muscle. The tendon is not ossified (Blasius).

Indurations in the vicinity of the nerves may give rise to very trouble-

some neuralgia as well as sensory and motor disturbances. Their treatment consists in massage and the use of electricity, or, best of all, in excision of the indurated tissue.

The various forms of acute and chronic periostitis and osteomyelitis occur occasionally in the humerus, especially in the neighbourhood of the epiphyses. Complete necrosis of the shaft has been observed after acute osteomyelitis, with or without its complete regeneration. The function of the arm has been well restored in consequence of regeneration of the bone even after total subperiosteal removal of the humerus, including the articular ends (Langenbeck). Resections of the entire humerus after injuries are not permissible. If regeneration of the bone does not take place—e. g., after necrosis of the whole shaft—the arm, which hangs powerless and dangling, must be rendered as useful as possible by supporting apparatus. Neudörfer had a case in which the arm could be well used actively without support. Pseudarthrosis sometimes arises from gummatous and tubercular osteomyelitis, which is overcome by scraping with a sharp spoon, by freshening and suturing the fragments, or by inserting one fragment into the medullary cavity of the other.

Sequestrotomy is performed on the humerus in accordance with

general rules (see Principles of Surgery, page 636). The fistulæ are found chiefly on the posterior surface of the bone. One should pay special attention thereby to the position of the nerves, especially the musculo-spiral, which may be displaced by the involucrum. In the depth of the wound one should operate by blunt dissection.

The tumours of the upper arm affect most commonly the bone—e. g., osteomata, enchondromata, also periosteal and myelogenic osteosarcomata of considerable size sometimes and great malignity, especially at the upper epiphysis (see page 547, Fig. 661). The prognosis is, as a rule, unfavourable, even in case of prompt resection, amputation, or disarticulation. The patient usually dies from recurrence. Echinococcus of the humerus has been observed repeatedly. In case of the

latter, external symptoms other than a partial enlargement of the bone may be absent for a long time. The diagnosis is made with certainty only after the cyst breaks through the bone with or without spontaneous fracture. The various benign and malignant tumours occur occasionally in the soft parts of the upper arm. They are operated upon according to general rules.

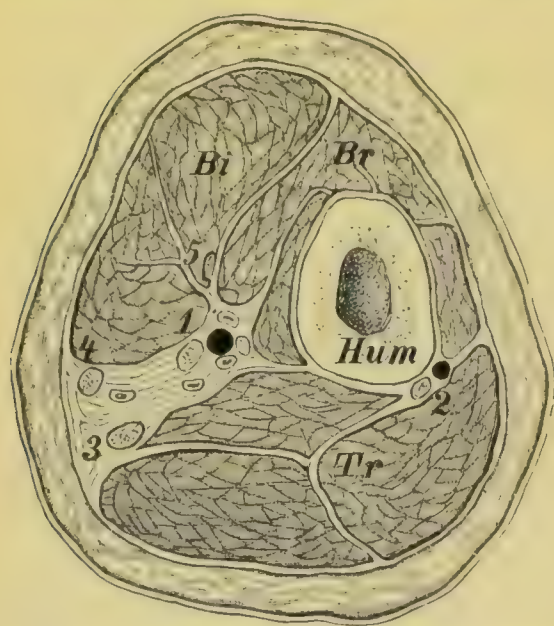


FIG. 672 — Appearance of the stump after amputation at the middle of the upper arm: *Bi*, biceps; *Br*, brachialis anticus with the end of the coraco-brachialis; *Tr*, the three divisions of the triceps; 1, brachial artery with the two veins and the median and musculo-cutaneous nerves; 2, superior profunda artery with the musculo-spiral nerve; 3, ulnar nerve; 4, internal cutaneous nerve; 5, external cutaneous nerve.

§ 285. **Amputation of the Upper Arm.**—Amputation of the upper arm is performed, as a rule, by means of the usual circular method. After the application of Esmarch's tourniquet about the shoulder as represented in Fig. 665, page 555, or about the upper third of the arm, the skin is divided circularly down to the fascia and then dissected up

from the latter on all sides, so that it can be reflected like a cuff. The length of the cuff must be equal to half the diameter of the limb. Near the point of reflection of the cutaneous cuff all the muscles are divided by a circular sweep of the knife down to the bone and the latter sawn through. All the vessels are caught and tied, including the brachial and superior profunda arteries. In case of high division of the brachial artery, its two branches are found, as a rule, side by side. The nerves are all drawn downward with forceps and cut off as short as possible with scissors. The appearance of the amputation stump is

shown in Fig. 672. The soft parts may also be divided at one stroke, or a flap method employed as shown in Figs. 646 and 647. In the former operation the soft parts, which are drawn well backward by an assistant, are divided down to the bone by sawing movements; the muscles are then detached from the bone somewhat farther up, and the latter sawn through at this point. If the assistant holds back the soft parts well, one obtains a funnel-shaped wound. In this operation, which is very properly much less used at present than formerly, one must take special care that there is sufficient covering of soft parts of the bone, as otherwise a conical stump easily results (see Principles of Surgery, page 125).

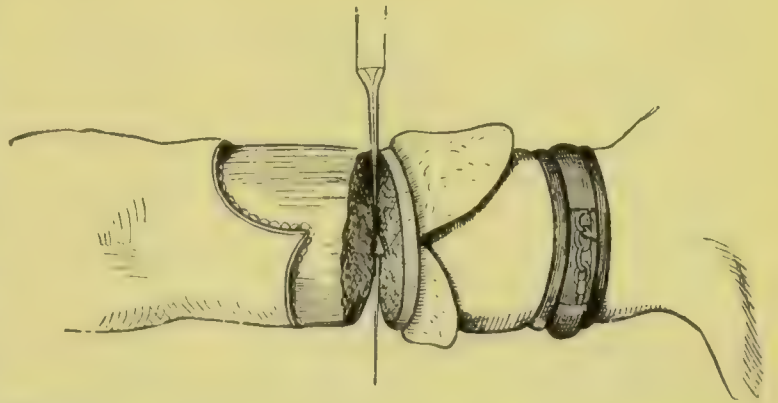


FIG. 673.—Amputation of the upper arm. Formation of a long anterior and short posterior skin-flap.

In flap amputations a long anterior and a shorter posterior cutaneous flap are formed (Fig. 555), or two flaps of equal length, or a single anterior overhanging flap, a semicircular incision being made behind (Fig. 674). The muscles are divided by a circular cut.

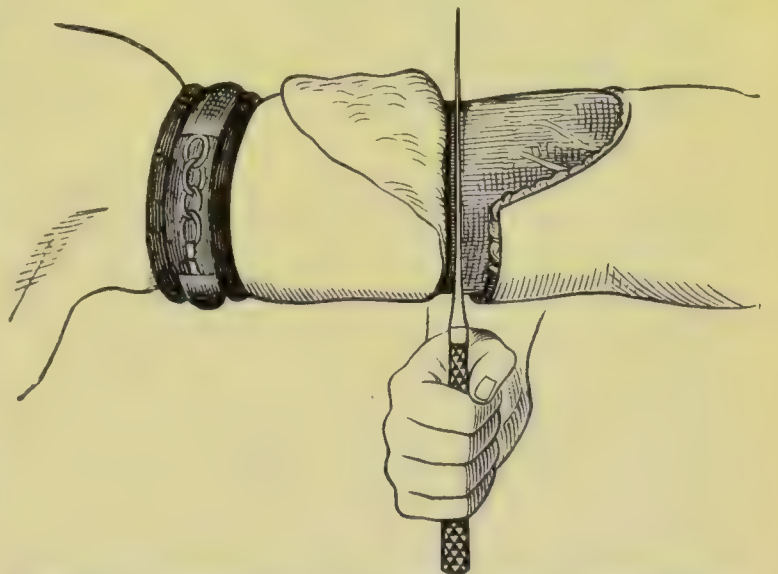


FIG. 674.—Amputation of the upper arm. Anterior overhanging flap with a posterior semicircular incision.

§ 286. **Injuries and Diseases of the Soft Parts in the Region of the Elbow (Skin, Bursæ, Vessels, Nerves, etc.).**—Extensive separation of the skin from the subjacent parts is not infrequently observed, with correspondingly large fluctuating extravasations of blood. Healing takes place most promptly by removal of the blood by means of an aseptic incision and by applying an antiseptic dressing that exerts pressure.

In case of wounds at the bend of the elbow with large skin defects, one must adopt special measures to prevent cicatricial contraction with contracture of the elbow joint. This is best accomplished by skin-graft-

ing, with the joint in an extended position, or, if the defects are very large, by means of pedunculated skin-flaps from the forearm, the upper arm, or the chest (Wagner and others). If a pedunculated flap is to be taken from the chest (Fig. 675) it is partially detached, sutured into the defect, without tension, and is freely smeared with vaseline to prevent it from drying. Oiled silk is laid under the flap near the pedicle to prevent its contact here with the surface of the wound. The arm is



FIG. 675.—Restoration of a skin defect at the bend of the elbow and on the forearm by means of a pedunculated skin-flap from the thorax: *a*, pedunculated skin-flap which is still connected with the thorax and has been sutured into the defect; *b*, after healing has taken place.

securely fixed to the thorax by gauze bandages or bandages of plaster of Paris or water glass. After the flap has healed in place the pedicle is severed. The large wound on the chest, the upper arm, or the forearm is covered by skin-grafts.

If cicatricial contraction of the elbow joint already exists, transverse division of the cicatrix, with the arm extended, and skin-grafting are sufficient in mild cases. Larger defects in the skin are covered by pedunculated flaps from the upper arm, the forearm, or the chest, as just described. Schede has overcome cicatricial contractions at the elbow simply by permanent extension. It is noticed that the cicatrix changes its location thereby, being drawn down more and more in the direction of the forearm.

Injuries and Inflammations of the Bursæ in the Region of the Elbow.—Of the bursæ in the region of the elbow, the following are constant: 1. The bursæ over and beneath the tendon of the triceps muscle on the posterior surface of the olecranon. 2. The bursæ over the external and the internal epicondyle; accessory bursæ also occur here. 3. The bursa upon the tuberosity of the radius beneath the insertion of the tendon of the biceps muscle. 4. The bursa between the radius and the ulna, likewise in the region of the tendon of the biceps muscle.

Effusions of blood (hæmatomata), serum, or pus within these bursæ give rise to circumscribed fluctuating swellings. Suppurative inflammations result usually from wounds of the bursæ treated without antiseptic precautions or from tuberculosis. Acute suppurative inflammations may occasion extensive cellulitis. A portion of the olecranon, for instance, not infrequently becomes necrotic after acute or chronic suppurative bursitis. Suppurative bursitis may extend to the elbow joint after a compound fracture of the olecranon which does not receive aseptic treatment. Serous and sero-fibrinous bursitis (hygroma) results most commonly from a hæmatoma of the bursæ. Gummatous (syphilitic) and gouty bursitis (bursitis urica) are not infrequently observed. In the latter case there are found in the bursæ white deposits of urates with thickening of the wall of the involved bursa. The diagnosis of all these diseases of the bursæ is made from the presence of a circumscribed swelling at the site of the bursa in question. The treatment of the different forms of bursitis conforms to generally accepted rules. In case of hæmatomata, massage and compression are employed, and aseptic incision, it may be, in case of slow absorption of the effusion of blood. Simple chronic, gummatous, and tubercular hygromata are treated by incision, curettage, and excision of the sac as completely as possible.

Nerve Injuries about the Elbow.—The most common injuries of the nerves in the region of the elbow are those of the ulnar nerve in its groove on the internal condyle—e. g., in consequence of a thrust or a blow, from fractures of the internal condyle, in connection with dislocations, or occasionally also with resection of the elbow joint, etc. The nerve may also be compressed by growth of the callus after fractures of the internal epicondyle and condyle. Aside from the injuries of the ulnar nerve, those of the median and the musculo-spiral are especially to be considered—e. g., in compound fractures and dislocations. For the symptomatology of injuries of the ulnar, median, and musculo-spiral nerves the reader is referred to the surgery of the forearm and the hand (§ 295, page 603 ff.). The occurrence of dislocations of the ulnar nerve from its groove on the internal condyle is also of special interest. It may take place, for instance, in case of abnormal smallness of the internal epicondyle and after malunion of fractures of the lower end of the humerus (Wallb, Zuckerkandl). The anomaly is sometimes bilateral and more or less habitual. The ulnar nerve can usually be distinctly felt beneath the skin as a displaced cord which slips to and fro. The elbow joint should be immobilized for a time after the reposition of the nerve, in order to retain the latter in its normal place. In case of habitual dislocations, one might deepen the groove on the condyle with the chisel and suture the nerve sheath with catgut to the tendon of the triceps muscle, for example. In addition to this, the sheath of the tendon may be drawn over the nerve as a protection and sutured to the periosteum.

Wounds of the cutaneous nerves which run over the veins of the bend of the elbow, made in performing venesection, especially the internal and external cutaneous nerves, sometimes give rise to subsequent neuralgia. This is best overcome by excision of the part of the skin which is involved, or by dividing the cutaneous nerve that is affected. After injury of a branch of the musculo-cutaneous nerve in performing venesection, Brodie saw reflex *main en griffe* result.

Wounds of the brachial artery at the bend of the elbow were more common formerly in connection with venesection, which was so frequently performed.

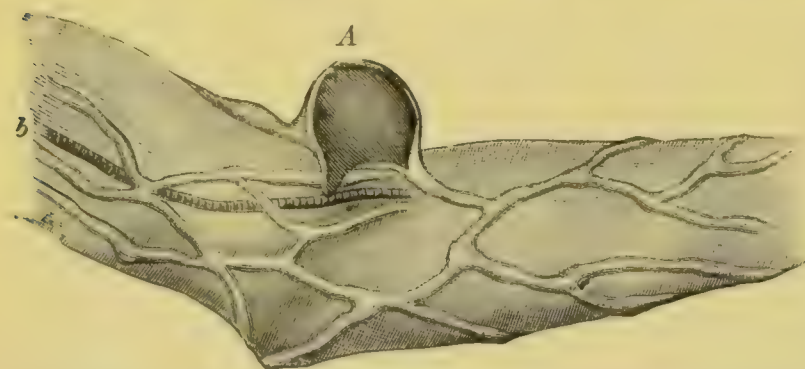


FIG. 676.—A, arterio-venous aneurism at the bend of the elbow following venesection; b, brachial artery. The aneurysmal sac, A, has been slit open (Froriep).

If the artery is wounded in this operation there results, as a rule, either an ordinary aneurism or an arterio-venous aneurism—that is, a communicating sac is formed between the artery and the

vein (Figs. 676 and 677). Such arterio-venous aneurisms sometimes give rise to marked circulatory disturbances in the arm, especially in the forearm and the hand (see also page 609, Fig. 716). A wound of the brachial artery at the elbow is treated by double ligation of the artery and of any arterial branches that go off from the place of injury. Aneurisms are treated by digital or instrumental compression of the brachial artery in the upper arm, by forced flexion of the elbow, or, best of all, by proximal and distal ligation of the artery, with incision and excision, it may be, of the sac (see particulars concerning aneurisms in Principles of Surgery, page 532 ff.).

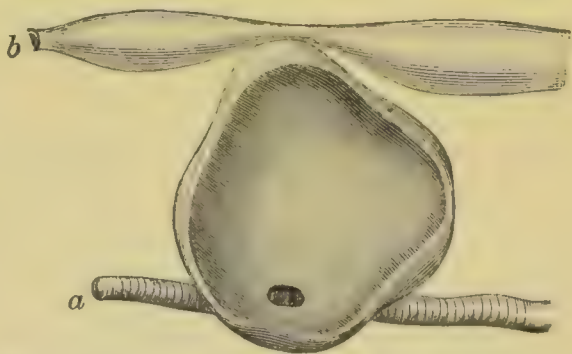


FIG. 677.—Arterio-venous aneurism: a, brachial artery; b, median basilic vein. The aneurysmal sac, which communicates with the artery and vein, has been slit open (Froriep).

Ligation of the Brachial Artery at the Bend of the Elbow.—The brachial artery lies here on the ulnar side of the tendon of the biceps muscle beneath the bicipital fascia. The median nerve lies to its inner side. The median basilic vein and the internal cutaneous nerve pass over the artery. At the level of the coronoid process of the ulna the artery usually divides into the radial and the ulnar. In case of high

division of the artery it is usually double at the elbow. One branch may lie in front of and the other behind the bicipital fascia.

In performing the operation the elbow joint is extended and the hand is in supination. The skin incision, which is five or six centimetres long, begins on the inner side of the biceps muscle and runs obliquely outward along the inner side of the biceps tendon. The median basilic vein is carefully pushed to one side. The bicipital fascia or its sharp edge is divided upon a grooved director, and the artery is isolated. The median nerve lies somewhat farther inward.

Inflammations of the veins at the bend of the elbow were not infrequently observed after venesection before the adoption of antiseptic methods in surgery, and death from pyæmia has sometimes followed suppurative phlebitis.

For the technique of venesection, see *Principles of Surgery*, page 458. Transfusion and infusion have been described in detail in *Principles of Surgery*, pages 481–484. Thanks to the investigations of Alexander Schmidt, A. Koehler, Worm-Müller, Bergmann, Angerer, and others, transfusion of blood is now but seldom employed. The infusion of a seven-tenths-of-one-per-cent solution of common salt, on the other hand, and subcutaneous injection of the same, have become more and more common (see *Principles of Surgery*, pages 479–484).

§ 287. **Fractures of the Lower End of the Humerus.**—We distinguish the following forms of fracture at the lower end of the humerus: (1) Fracture above the condyles; (2) the same fracture, combined with an intercondyloid fracture penetrating into the joint (so-called T- or Y-fracture); (3) separations of the lower epiphysis; (4) intracapsular fracture of the articular portion of the humerus; (5) fracture of the internal epicondyle and condyle; (6) fracture of the external epicondyle and condyle. There are, of course, numerous transitions between these principal types of fracture and manifold combinations. In making the diagnosis of fractures and dislocations in the region of the elbow joint one should always compare the elbow joint of the other side with the injured joint and take note of the different bony prominences with the forearm flexed and extended.

1. **Fracture of the Humerus above the Condyles** (supracondyloid fracture) is a transverse, less frequently an oblique, fracture, and it is often complicated by fissures penetrating into the elbow joint (see page 573, Figs. 679 and 680). The fracture usually arises from direct, less often from indirect, violence—e. g., from violent rotation and abduction of the forearm, or from a fall upon the hand with the forearm hyperextended so that the olecranon breaks off the articular end. The fracture occurs most frequently in children and young persons. In typical

cases the deformity is much the same as in backward dislocation of the elbow (see Fig. 678)—that is, the bones of the forearm, with the articu-

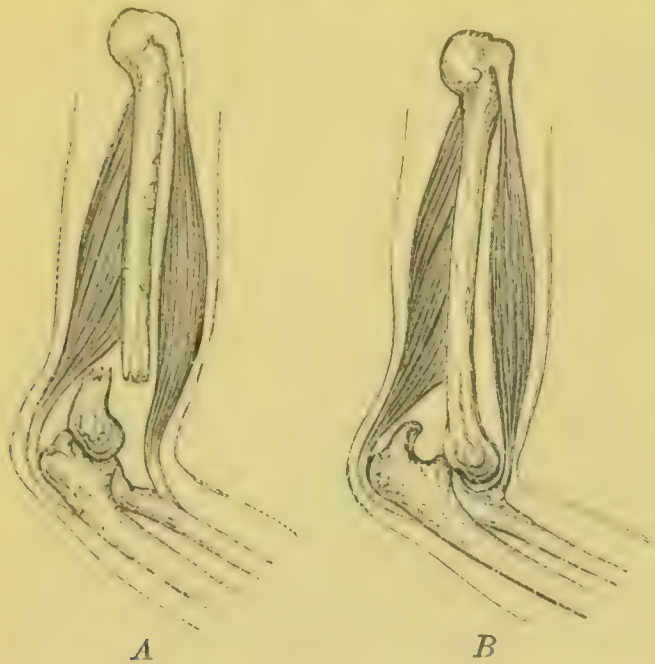


FIG. 678.—*A*, supracondylar fracture of the humerus; *B*, backward dislocation of the elbow (diagrammatic).

lar end of the humerus which is broken off, are displaced backward and upward in consequence of the traction of the triceps muscle. The upper fragment is in front of the lower one, and can sometimes be felt in the bend of the elbow. The distinction between fracture and dislocation is, however, very apparent from Fig. 678. In dislocation the olecranon is very prominent, the epicondyles are not in their normal position, the elbow joint is fixed, the articular end of the humerus can be felt in the bend

of the elbow, and there is no abnormal mobility above the joint as in fracture, in which the joint is movable. The upper fragment sometimes perforates the soft parts (compound fracture). Displacements precisely the opposite of that shown in Fig. 678 *A* also occur; likewise simple angular position of the fragments or marked overriding. The lower fragment is sometimes rotated about the transverse axis so that the fractured surface is directed forward.

The diagnosis of supracondylar fracture of the humerus is based especially upon the deformity that has just been described, upon the abnormal mobility and the effusion of blood above the joint, which is ordinarily freely movable; also upon crepitus when the fragments are moved or touched, upon the shortening of the humerus, and upon the presence of a localized point of tenderness. In case of incomplete fractures without displacement and of impacted fractures the localized point of tenderness is of great diagnostic importance.

2. Supracondylar fracture is sometimes combined with intercondylar fracture into the joint, giving rise to a T- or Y-fracture. The single fragments either remain united, as in Figs. 679 and 680, or they are completely separated from one another. In case of complete separation of the fragments, the elbow joint is usually strikingly broadened and the condyles show abnormal mobility, accompanied by severe pain and crepitus. The upper fragment sometimes

forces itself between the lower ones and drives them apart. In other cases the entire lower articular end is shattered into a number of fragments (comminuted fracture)—e. g., from gunshot injuries or a fall upon the elbow (Fig. 654). The fracture is sometimes combined with backward dislocation of the bones of the forearm, or the radius and ulna remain connected with the lower fragments, and are, it may be, pushed backward and upward. These fractures arise usually from the action of great violence upon the olecranon, which drives the condyles apart like a wedge (Madelung)—e. g., from a fall upon the elbow. In the latter case the frac-



FIG. 679.—T-shaped fracture of the lower end of the humerus.



FIG. 680.—Y-shaped fracture of the lower end of the humerus (Bruns).



FIG. 681.—Comminuted fracture of the lower end of the humerus from a fall upon the elbow (Bruns).

ture above the condyles occurs first, and the upper fragment then forces the condyles apart. Of the nerves, the ulnar and median may be more or less injured.

3. Separation of the Lower Epiphysis.—The epiphyseal line at the lower end of the humerus runs just below the coronoid fossa in front and the olecranon fossa behind from one epicondyle to the other. According to Schüller, transverse separations of the epiphysis at the lower end of the humerus are rather frequent until about the twelfth year. They arise sometimes from direct, but most commonly from indirect violence—e. g., from violent rotation of the forearm, from hyperextension, abduction or adduction of the same in falling upon the hand, for instance. The symptomatology is essentially the same as that of simple transverse supracondyloid fracture. The age of the patient is always a strong indication in favour of separation of an epiphysis as well as a soft cartilaginous crepitus.

4. Fracture of the Articular Surface of the Humerus, which is intracapsular and is covered with cartilage. The complete breaking off of the articular surface always results from direct violence, and is almost always accompanied by fracture of the olecranon. Extensive com-

minution of the articular end, with long fissures, as represented in Fig. 681, is observed especially in gunshot injuries. Indirect violence—e. g., a fall upon the hand, causes only incomplete breaking off of the articular portion, particularly of the capitellum by the head of the radius. Complete intracapsular fracture of the lower articular surface of the humerus is characterized by crepitus and abnormal mobility below the epicondyles, upon fixation of the latter and lateral movement of the forearm, by simultaneous fracture of the olecranon, by abnormal passive mobility of the elbow joint while it is but slightly movable actively, and, finally, by swelling of the joint in consequence of the intra-articular effusion of blood. Sometimes, however, the fracture is partly intracapsular and partly extracapsular. In extensive comminuted fractures the diagnosis is usually easy. If, in consequence of a fall upon the hand, only the capitellum of the humerus is broken off by the radius, crepitus is demonstrable by pronation and supination of the forearm and placing the hand upon the external condyle. There is usually a distinct projection in front of the external epicondyle, and behind this is found the head of the radius.

5. Fracture of the Internal Epicondyle and Condyle.—The rather frequent fractures of the internal epicondyle which occur among children (Fig. 682) are really to be regarded as



FIG. 682.—Fracture of the internal epicondyle and condyle of the humerus (diagrammatic).

separations of the epicondyle from the condyle through the epiphyseal line. The line of fracture is always extracapsular, and it is not infrequently combined with fissures running into the joint. The fracture is sometimes observed in connection with lateral dislocation of the elbow. It occurs sometimes from direct and sometimes from indirect violence—e. g., from avulsion of the process by the internal lateral ligament. The fracture is characterized by abnormal mobility and crepitus over the internal epicondyle, which is often displaced in one direction or another; also by effusion of blood, and by pain at

the site of the fracture as well as at the termination of flexion and extension of the forearm. There are sometimes functional disturbances in the distribution of the ulnar nerve. In case of lateral dislocation of the bones of the forearm the internal epicondyle can sometimes not be felt.

Fracture of the internal condyle is partly intracapsular and partly extracapsular (Fig. 682). In children the line of fracture within the

joint usually corresponds with the epiphyseal cartilage between the capitellum and the trochlea. The internal condyle either remains in its normal situation or it is displaced, especially inward, upward, and backward, less often downward and forward, when the periosteum and the capsule are severely torn. The ulna follows this displacement, and the radius may be completely or incompletely dislocated. In other cases both bones of the forearm are dislocated backward. The fracture as such is characterized by swelling of the inner part of the joint and by abnormal mobility and crepitus upon grasping and moving the internal condyle. There are sometimes functional disturbances in the distribution of the ulnar and median nerves.

6. Fracture of the External Epicondyle and Condyle (Fig. 683).—Fracture of the external epicondyle is much rarer than that of the internal epicondyle, because the former is much less prominent (see Figs. 682 and 683). The fracture is always extracapsular, arises usually from direct violence, and sometimes accompanies backward and lateral dislocations of the elbow. The symptoms are similar to those accompanying fractures of the internal epicondyle. The epicondyle which is broken off is displaced upward or downward.

Fracture of the external condyle (Fig. 683), like that of the internal condyle, is partly intracapsular and partly extracapsular. It is observed most commonly among children—e. g., from a fall upon the external condyle or indirectly from a fall upon the hand, from violent abduction and rotation of the forearm, etc. Either there is no displacement or the fragment is displaced upward and backward or backward and outward. There is frequently a simultaneous outward dislocation of the radius or of both bones of the forearm outward and backward. The fracture is, as a rule, easy to detect from the abnormal mobility and crepitus which are obtained by grasping and moving the external condyle.



FIG. 683.—Fracture of the external epicondyle and condyle of the humerus (diagrammatic).

The prognosis of fractures of the lower end of the humerus is, generally speaking, favourable. In case of simple fractures bony union usually follows in from three to four weeks without appreciable functional disturbance of the elbow joint. Sometimes, however, the function of the elbow is permanently impaired to a greater or less degree—e. g., by malunion of the fracture, by overproduction of callus, by growths of callus into the capsule, by a so-called “bridge callus,” by detached splinters of bone which lie in the joint, by direct adhesions of the articular surfaces, by contraction of the capsule and the surrounding soft parts, etc. The prognosis of compound

comminuted fractures is the most unfavourable. The prognosis is sometimes very unfavourably influenced by extensive injuries of the soft parts, by injuries of the vessels and nerves, and by simultaneous dislocations.

The treatment of all fractures of the lower end of the humerus conforms essentially to the same rules. In all simple fractures one should, after overcoming any existing displacement by suitable traction and pressure, immobilize the arm, flexed at right angles at the elbow, by means of a suitable splint which reaches to the wrist. The forearm should be midway between pronation and supination, so that its radial border is directed upward. Instead of the right-angled position of the elbow joint, the immediate fixation of the same in an extended position can be recommended when a patient is treated in a hospital, but in case of treatment in a dispensary the former position is more convenient for the patient. Plaster of Paris makes an excellent splint (*Principles of Surgery*, page 216), or plaster of Paris and hemp, with which one can also immobilize the shoulder joint well (see Fig. 637 page 513). Splints of pasteboard, felt, gutta-percha, wood, cellulose, etc., are also useful (see *Principles of Surgery*, page 206 ff.). In case the deformity can not be permanently overcome, the ends of the bone may be cut down upon and wired or nailed together. If there is marked swelling at the site of fracture, the arm may be placed for a time in a proper elevated position on a splint, and, if necessary, ice should be applied. Whatever variety of splint one chooses, the treatment should above all be so arranged that the elbow joint shall not remain too long in the same position, in order that it may not become stiff. The first splint should therefore be taken off after eight or ten days, the elbow joint carefully examined with reference to its mobility, and the second splint applied, it may be, with the joint in a different position. After three or four weeks, and even earlier in the case of children, massage and passive movements are begun. Stiffness of the elbow joint is most surely avoided in this way. If ankylosis of the joint occurs after union of the fracture, the attempt should be made, with the patient under an anæsthetic, to render the joint movable again, massage should be regularly employed, use made of active and passive movements and, if necessary, of permanent extension or adjustable splints, etc. As a last resort, resection of the joint may come into consideration. If ankylosis can not be avoided, the elbow joint must be kept in a right-angled or slightly acute-angled position. Compound fractures, injuries of the nerves and vessels, etc., are treated with antiseptic precautions and according to general rules (see *Principles of Surgery*, page 597 and page 729, Gunshot Fractures). Comminuted fractures often demand immediate resection or amputation.

§ 288. **Fractures of the Upper End of the Ulna and the Radius (Fractures of the Olecranon, the Coronoid Process of the Ulna, the Head and Neck of the Radius).**

1. **Fractures of the Olecranon.**—The not infrequent fractures of the olecranon arise chiefly from direct violence when the elbow joint is bent at right angles; also indirectly, from hyperextension of the forearm—e. g., in falling upon the hand. In exceptional cases fractures have been caused by violent contraction of the triceps—from throwing, for example. Transverse fractures near the tip or at the middle of the olecranon are the most common, those of the base occurring less often. Direct fractures are often complicated by injury of the covering of soft parts. If the periosteum and the tendinous expansion of the triceps which unites with the capsule are ruptured at the same time, the fragment of bone that is broken off may be displaced upward. Fractures of the olecranon are sometimes complicated by dislocation of the forearm backward, or by fracture of the articular surface of the humerus (see page 571 ff.). The diagnosis of the fracture is easiest when the fragment of bone that is broken off is displaced upward and there is a distinct gap between the fragments, or in case of a compound fracture. Even when there is no displacement, however, the abnormal mobility of the bone can usually be easily made out. If there is a marked effusion of blood in the olecranon bursa and its vicinity, it is advisable to overcome this as far as possible by massage, in order to be able to palpate the line of fracture more satisfactorily.

Pseudarthrosis easily ensues in case of diastasis of the fragments, which interferes especially with extension at the elbow joint, but also with flexion. This is the more marked, the more relaxed and the longer the fibrous union between the fragments is. Another cause of the frequent pseudarthrosis following fracture of the olecranon is the interposition of the aponeurosis between the fragments (Macewen). In case of pseudarthrosis, increasing arthritis deformans is by no means infrequently observed, with marked functional disturbance of the elbow joint. In other cases, disturbances in movement, or, it may be, complete ankylosis, are to be feared, especially after compound comminuted fractures, with necrosis of the fragments of bone, and after suppurative inflammation of the elbow joint.

Treatment of Fractures of the Olecranon.—In case of simple fractures, it is important to overcome any diastasis of the fragments. The latter are brought together, with the elbow extended, by means of a small wad of cotton above the upper fragment and longitudinal strips of adhesive plaster. Strips of adhesive plaster are then placed above

these in a transverse direction, which must not, however, encircle the whole arm. The arm is then immobilized in an extended position by means of plaster of Paris, use being made, it may be, of an anterior splint for the arm, reaching from the axilla to the wrist. During the hardening of the plaster-of-Paris splint it should be pressed in somewhat around the borders of the olecranon. The first splint should be changed after eight or ten days. After four or five weeks, gradually increasing flexion of the arm is allowable. Large effusions of blood are overcome, before the application of the dressing, by massage, by temporary use of India-rubber bandages, or, it may be, by puncture of the olecranon bursa.

Should the coaptation of the fragments be attended with difficulty, one may employ Malgaigne's hooks, or, better, aseptic suture with cat-gut, silkworm gut, or silver wire. Suture is especially indicated in case of recent compound fractures. The treatment of the latter should conform to general rules. In case of comminuted fracture with a large wound in the skin, removal of the splinters is to be recommended. If ankylosis of the elbow joint is anticipated after a compound comminuted fracture or after suppurative inflammation of the joint, the splint must be applied with the elbow joint bent at a right angle or a slight acute angle, because the arm is much more useful in this position than when extended.

2. Fracture of the Coronoid Process of the Ulna.—These fractures occur most commonly in connection with backward dislocations of the forearm or the ulna. When they occur alone they result usually from a fall upon the ulnar side of the hand with the elbow bent at an obtuse angle, as has also been determined by experiments upon the cadaver. In exceptional cases the coronoid process of the ulna may be torn off by violent contraction of the brachialis anticus muscle. There is either a fissure only, or the process is broken off at the apex or at the base. In the latter case the fragment either remains attached to the capsule or lies free in the joint.

The symptoms of fracture of the coronoid process of the ulna, without backward dislocation of the latter or both bones, are so little characteristic that a probable diagnosis only is possible. The most important symptoms indicative of a fracture of this process are an intra-articular effusion of blood and severe pain caused by palpation of the region of the coronoid process in the bend of the elbow and by active contraction of the brachialis anticus muscle—that is, active flexion of the pronated forearm. If the base of the process is broken off, the olecranon is noticeably prominent behind. One sometimes feels the detached fragment of bone in the bend of the elbow, and crepitus can be made out.

If there is a simultaneous backward dislocation of the ulna or of the forearm it can be reduced with striking ease, but the deformity recurs at once. The prognosis of the fracture is, generally speaking, favourable. Bony union is the more likely to follow the less the diastasis of the fragments. If pseudarthrosis ensues, there may remain a tendency to backward dislocation of the ulna or of both bones of the forearm, or to outward dislocation of the radius. The active contraction of the brachialis anticus muscle may also remain impaired, though this does not necessarily involve functional disturbance of the joint. Functional disturbances of the joint may also arise from a hypertrophic intra-articular callus.

The treatment of a fracture of the coronoid process of the ulna consists in immobilizing the elbow joint, which is flexed at right angles or at an acute angle, for about a fortnight, by means of a plaster-of-Paris splint. Cautious use is then made of methodical exercise of the joint and massage, in order to prevent ankylosis. During the following week the joint should be fixed sometimes at an acute angle and sometimes at a right angle.

3. Fracture of the Head of the Radius.—Intra-articular fracture of the head of the radius arises sometimes from a direct thrust or blow or gunshot wound; sometimes from a fall upon the pronated hand or from violent pronation (P. Bruns). Either there are fissures only, or a piece of the head is broken off and lies free in the joint or still remains attached to the capsule or the annular ligament. The head is sometimes shattered into several fragments. The fracture may be combined with separation of the epiphysis between the head and the shaft or with fracture of the neck of the radius—e. g., among children, in consequence of violent pronation. Not infrequently there are other coexisting injuries in the region of the elbow—e. g., fracture of the external condyle of the humerus, of the olecranon, of the coronoid process, or backward dislocation of the radius or of both bones of the forearm.

Complete fractures of the head of the radius are characterized by pain and crepitus when the head is fixed and the forearm rotated, whereby one can sometimes distinctly feel the movable fragment of bone; also by more or less pronounced interference with pronation and supination. The posterior interosseous nerve, which passes over the anterior surface of the head, is sometimes injured, so that there may be corresponding paralysis of the hand (see § 295, page 603). One must always examine the elbow joint with reference to the presence of the above-mentioned complications.

The prognosis of the fracture is, generally speaking, favourable. In case of simple fracture, bony union usually ensues. Fragments of

bone that are completely broken off and lie in the joint may become free movable bodies in the same (Hueter). Pronation and supination of the forearm are easily restricted by a hypertrophic callus.

The treatment of fracture of the head of the radius consists in immobilizing the forearm for two or three weeks, which is flexed at right angles and semi-pronated, then in massage and systematic exercise of the joint; the wrist joint is to be included in the splint. The latter is to be changed every week, and when this is done the forearm should be rotated in order that pronation and supination of the hand may not become impaired. Functional disturbances in consequence of malunion of a fracture are overcome by resection of the head of the radius.

4. Fracture of the Neck of the Radius.—By fracture of the neck of the radius is understood a fracture between the insertion of the capsule and the tuberosity of the radius. In children there is usually a separation of the epiphysis. Isolated fractures of the neck of the radius are rare. They are more common in connection with backward dislocation of the ulna and with fracture of the coronoid process of the latter. They are caused sometimes by the action of direct violence, sometimes indirectly—e. g., in consequence of violent pronation. The diagnosis of the fracture is rendered difficult by the thick cushion of muscles—viz., the supinators and the extensores carpi radiales. In case of complete fracture, the lower fragment may be drawn forward and upward by the biceps muscle, so that there is then a tender bony prominence to be felt on the corresponding flexor side of the elbow joint. In case of complete separation of the neck of the radius, the head of the radius no longer follows the rotatory movements of the hand. The forearm remains in pronation, and can not be actively pronated or supinated. Crepitus can be made out by rotation of the forearm. The prognosis of this fracture is usually favourable.

In treating fracture of the neck of the radius the biceps muscle is to be relaxed as far as possible by flexion of the elbow joint, and a plaster-of-Paris or wood splint is then to be applied. If the lower fragment is displaced in a forward direction, one lays a wad of cotton upon it, and has the fragment held in its proper place by means of a strap while the plaster-of-Paris splint is being put on.

§ 289. **Dislocations of the Elbow.**—About half of all the dislocations of the elbow occur among children under fifteen years of age. We distinguish the following forms of dislocation:

1. Backward, forward, or lateral (outward or inward) dislocation of both bones of the forearm.
2. Divergent dislocation of both bones—e. g., backward dislocation of the ulna and forward dislocation of the radius.
3. Forward, outward, and backward dislocation of the radius.

4. Backward dislocation of the ulna. The backward dislocations of both bones of the forearm and those of the radius are the most common.

I. Dislocation of both Bones Backward.—This most frequent form of dislocation is sometimes complete and sometimes incomplete. If complete, the end of the humerus lies in front of the coronoid process and upon the neck of the radius (Fig. 684). If incomplete, the coronoid process and the border of the head of the radius are in contact with the lower surface of the trochlea and the capitellum.

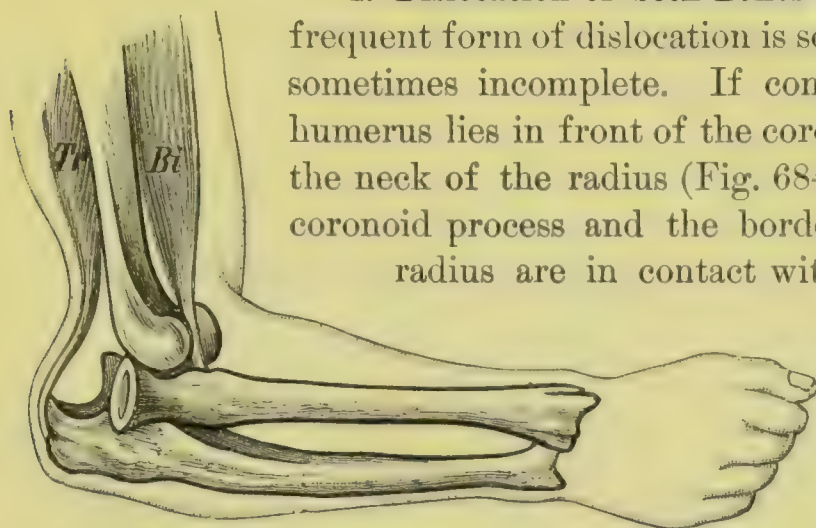


FIG. 684.—Backward dislocation of the elbow (diagrammatic):
Tr, triceps; *Bi*, biceps.

Etiology.—Dislocations of the forearm backward arise most frequently from a fall upon the palm of the hand. In this way a

hyperextension (dorsal flexion) of the elbow takes place. The olecranon acts as a lever by pressing against the olecranon fossa, and the lower end of the humerus is forced forward, rupturing the capsule, so that the humerus is really the dislocated part. The bones of the forearm are held in a flexed position by the biceps, the brachialis anticus, the untorn portion of the capsule, and the ligaments (Figs. 684, 685). This dislocation

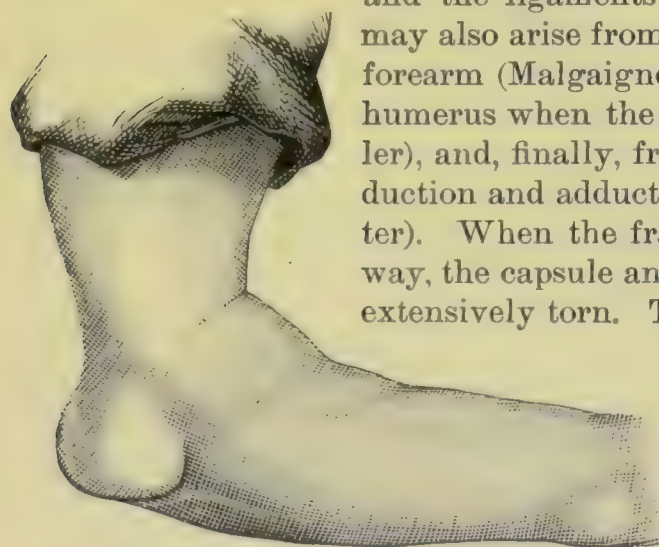


FIG. 685.—Backward dislocation of the elbow caused by a fall upon the lower end of the humerus.

may also arise from a blow upon the inner side of the forearm (Malgaigne) or upon the posterior side of the humerus when the elbow joint is semi-flexed (Schüller), and, finally, from violent lateral movements (abduction and adduction) of the forearm (Schüller, Stetter). When the fracture originates in the last-named way, the capsule and the lateral ligaments are usually extensively torn. The following associated injuries of

the soft parts may occur in severe cases: Rupture of the brachialis anticus muscle, contusion, stretching or rupture of the vessels and nerves of the bend of the elbow (brachial artery, median nerve, branches of the musculo-spiral, displacement of the ulnar nerve).

In such severe lacerations of the soft parts the skin also may be divided, so that the humerus is visible in the bend of the elbow. There are sometimes associated fractures, especially of the coronoid process, the olecranon, the head and the neck of the radius, the inferior articular surface of the humerus, and the epicondyles or the condyles of the humerus. The external condyle, for example, may be broken, if the dislocation arises when the hand is fixed and sharply pronated, from overextension of the elbow joint, radial abduction, and subsequent flexion of the forearm (F. Fischer).

The symptoms of a complete dislocation of the bones of the forearm are very distinct, especially just after the injury. The deformity is usually somewhat obscured later by the increasing effusion of blood. As appears from Figs. 684 and 685, the olecranon and the head of the radius are abnormally prominent behind and above. Above this projection there is a depression, because the humerus is displaced forward. The tense tendon of the triceps muscle is distinctly felt under the skin, and the lower end of the humerus is felt in the bend of the elbow. The normal relations of the bony prominences to one another—that is, of the olecranon to the condyles and of the head of the radius to the external condyle—are correspondingly altered. The forearm is more or less flexed at the elbow joint, is midway between pronation and supination, and is visibly shortened. The elbow joint is not at all movable actively, and but very little passively. Flexion is prevented mainly by the tense ligamentous bands which pass from the epicondyles of the humerus to the upper extremities of the bones of the forearm (E. Zuckerkandl). The bones of the forearm are sometimes dislocated not directly backward, but somewhat to one side as well, especially outward. One should always look out for any of the above-mentioned associated injuries, especially those of the vessels, the nerves, and the bones. Fracture of the coronoid process is probable if the dislocation can be reduced without difficulty and then recurs immediately. As regards differential diagnosis, supracondyloid fracture of the humerus may have to be considered (see page 571).

In incomplete dislocation of the bones of the forearm backward all the symptoms that have just been mentioned are less pronounced. The olecranon and the head of the radius, for example, do not project so sharply.

The prognosis of dislocation of both bones backward is the more favourable the sooner reduction follows after the injury. After a duration of from four to six weeks the dislocation is usually irreducible, and only in exceptional cases has reposition still been successful after from twelve to sixteen weeks. If the dislocation is not reduced, all movements of the elbow joint (flexion, extension, pronation, and supination) are, as a rule, seriously disturbed. Important functional disturbances of the elbow joint may also arise from fractures that are not recognised, and from compound dislocations which do not receive aseptic treatment.

Treatment of Dislocations Backward.—There are various methods of reduction applicable to backward dislocation of the bones of the forearm, of which I mention especially the following :

1. Hyperextension of the elbow, after Roser (Fig. 686). The elbow is laid upon the surgeon's knee, extended beyond the horizontal, and

then quickly flexed with simultaneous traction on the forearm. An assistant presses upon the olecranon from behind.

2. Forcible flexion, after Sir Astley Cooper. The surgeon places his knee in the bend of the elbow, grasps the wrist joint of the dislocated arm, and flexes

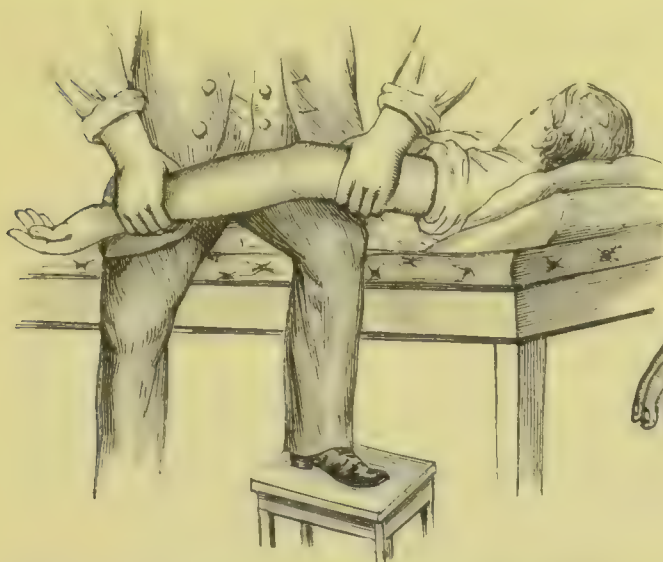


FIG. 686.—Reduction of backward dislocation of the elbow.

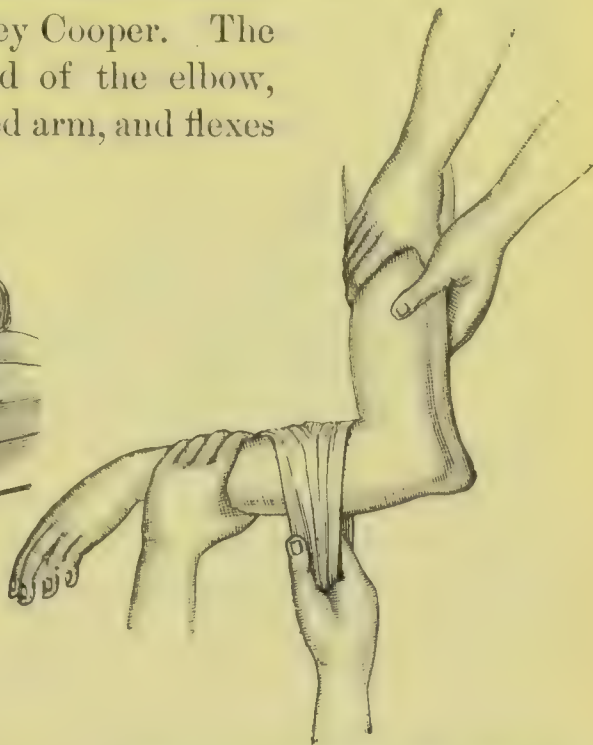


FIG. 687.—Reduction of backward dislocation of the elbow.

the forearm so that the knee exerts a direct pressure upon the radius and the ulna, in order to free the coronoid process from the olecranon fossa. If the elbow joint is now sharply flexed, reduction usually succeeds at once, especially if traction is employed to some extent at the same time. The arm also may be placed in the bend of the elbow instead of the knee and pressed against the humerus. Traction is applied to the forearm bent at right angles, the elbow is then flexed still more, and pressure is applied from behind against the olecranon.

3. Dumreicher used the method of reduction represented in Fig. 687. With the elbow flexed at right angles the forearm is drawn straight downward in the elongated axis of the humerus by means of a sling.

Counter-extension is employed from within the axilla or upon the upper arm, and extension, and finally flexion, of the forearm follow.

II. **Dislocation of both Bones Forward** (Fig. 688).—This dislocation is very rare, and it is only possible from a blow or a fall upon the

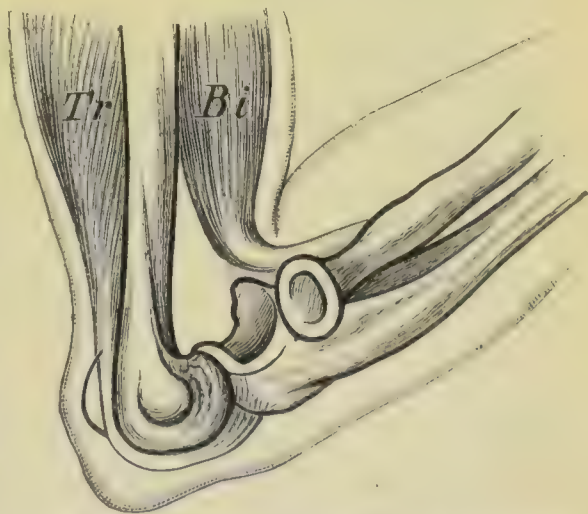


FIG. 688.—Forward dislocation of the elbow.

olecranon while the arm is sharply flexed. A fracture of the lower end of the humerus or of the olecranon is much more likely to occur, however, from the action of this violence. In rare cases the dislocation has occurred with the elbow joint in an extended position, but only after previous fracture of the olecranon. It has been known to occur, finally, from violent rotation of the forearm. In complete forward dislocation of the forearm the tip of the olecranon lies in front of the anterior surface of the lower end of the humerus (Fig. 688). In incomplete dislocation the upper end of the olecranon is in contact with the trochlea, and may be somewhat displaced laterally. The symptoms are essentially the same in both cases. The forearm is flexed at an acute angle and seems elongated; the olecranon is not to be felt at its normal location, but one feels in its place the tense tendon of the triceps muscle and the lower articular surface of the humerus. The sigmoid cavity of the ulna and the head of the radius are usually to be distinctly felt in the bend of the elbow. If the olecranon is broken off, it is found as a movable fragment usually in its normal place. Of the nerves, the ulnar nerve is most likely to be displaced, and corresponding symptoms of paralysis of the same may result.

The prognosis of this dislocation is, generally speaking, favourable. Reduction is accomplished by hyperflexion while one exerts pressure upon the bones of the forearm with the braced knee or arm, as in backward dislocation of the forearm, and in this way pushes them backward. Reduction may also be effected by extension of the forearm

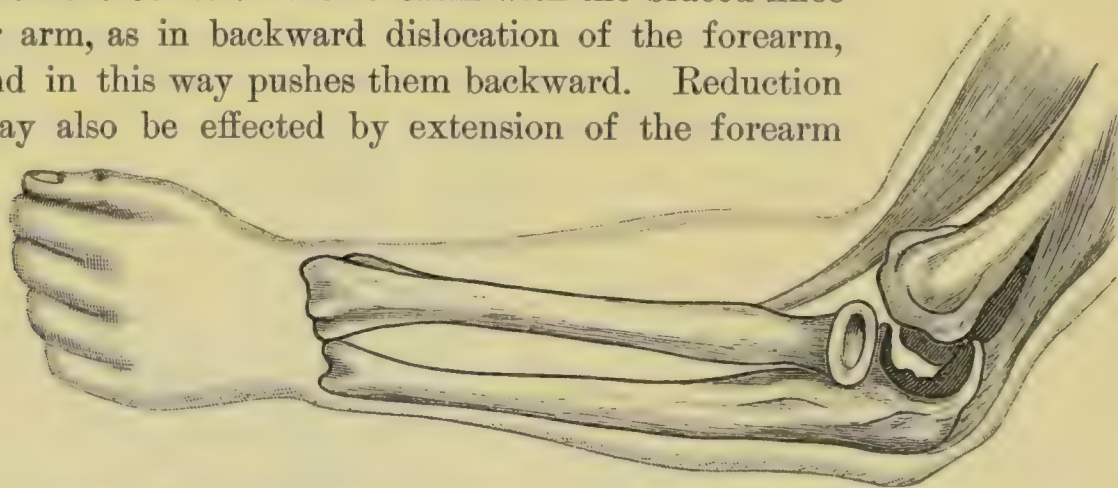


FIG. 689.—Incomplete outward dislocation of both bones of the forearm (diagrammatic).

with pressure from in front backward and from above downward upon the bones of the forearm, as well as from behind upon the humerus.

III. Lateral Dislocation of both Bones of the Forearm.—The very rare dislocations of both bones of the forearm in an outward or inward direction are almost always incomplete.

In case of incomplete outward dislocation of the bones of the forearm, which is the most frequent, the sigmoid cavity of the ulna lies

upon the capitellum which has been left by the head of the radius; the head of the radius is found to the outer side of the external condyle of the humerus and forms here a distinct prominence (Fig. 689). The lateral diameter of the elbow joint is increased, the internal condyle of the humerus projects sharply,

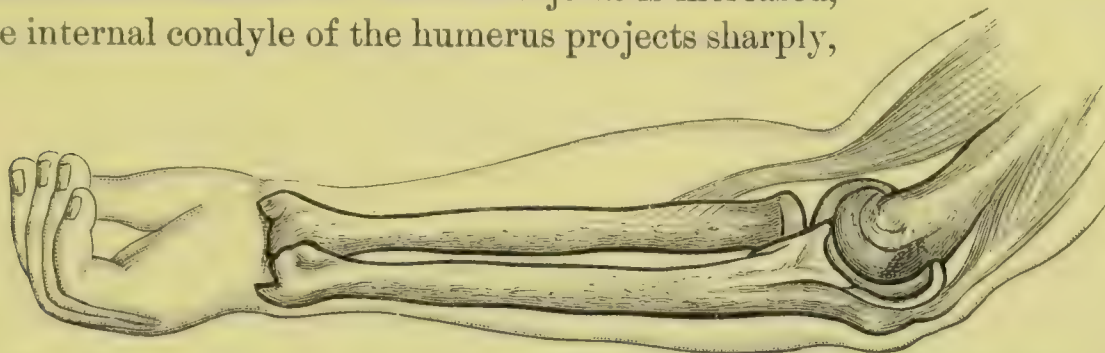


FIG. 690.—Incomplete inward dislocation of both bones of the forearm (diagrammatic).

the olecranon is displaced in the direction of the external condyle of the humerus, and the forearm is more or less flexed, pronated, and only slightly movable.

In the rare incomplete inward dislocations of the bones of the forearm the deformity is directly the reverse. The sigmoid cavity of the ulna leaves the articular surface of the humerus and is in contact with the internal condyle and projects here; the olecranon is found behind the internal condyle of the humerus, and the head of the radius is in contact with the trochlea (Fig. 690). The elbow joint is here also strikingly broadened.

In exceptional cases complete outward or inward dislocations of both bones of the forearm are observed, resulting from the action of considerable violence, so that both bones lie alongside the humerus. Complete outward dislocations of both bones of the forearm are the more frequent. The deformity attending complete lateral dislocations is clear, from what was said above. The ulna and radius may in exceptional cases be rotated in consequence of severe laceration of the soft parts—that is, in a complete outward dislocation, for instance, the sigmoid cavity may embrace the outer surface of the humerus (so-called “rotation dislocation” of the elbow, Fig. 691).

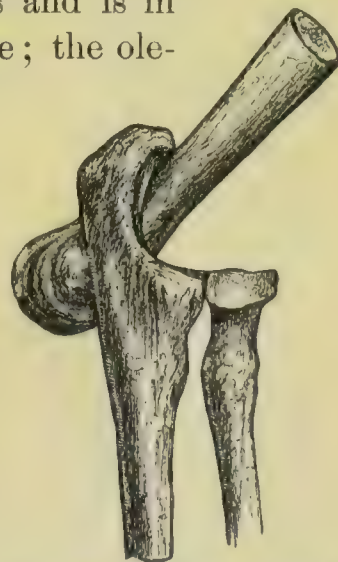


FIG. 691.—“Rotation dislocation” of the elbow.

Among associated fractures there are especially to be considered, in connection with lateral dislocations of the forearm, those of the external and the internal epicondyle, of the head of the radius, of the coronoid process, and of the trochlea.

The lateral dislocations of the forearm arise chiefly from the action

of great violence, and are therefore accompanied by an extensive rupture of the capsule and a marked effusion of blood. The capsule is usually torn in front and behind, and the lateral ligaments also are for the most part ruptured on both sides. The nerves are not infrequently injured, especially the ulnar, in inward dislocations. Lateral dislocations of the forearm have occurred in most cases from a fall upon the hand with hyperextension and lateral flexion of the forearm, or from the action of direct violence upon the forearm or the humerus near the elbow.

The prognosis of lateral dislocations of the forearm, so far as the complete restoration of the function of the elbow joint is concerned, is not very favourable, in consequence of the usually severe violence that has been exerted, of the serious injury of the soft parts, and of possible fractures.

The reduction of these dislocations is usually easy on account of the extensive tearing of the capsule. It can, however, be rendered difficult, especially by interposition of the epicondyles that have been broken off and the tendon of the biceps.



FIG. 692.—Divergent dislocation of the elbow (dislocation of the ulna backward and of the radius forward).

Outward dislocation of both bones is reduced by extension upon the forearm and by forcing at the same time the bones of the forearm inward and the humerus outward by means of direct pressure. The dislocation may also be reduced by hyperextension, abduction, adduction, and flexion of the forearm. In place of flexion one can employ direct pressure upon the dislocated bones.

In case of inward dislocation of the forearm, reduction is likewise effected by extension and direct pressure upon the dislocated bone or by hyperextension, adduction, and flexion of the forearm.

If reduction is impossible, one should cut down upon the site of dislocation with antiseptic precautions and then proceed according to what is found to be the condition of things, removing, it may be, an interposed condyle, for example, that has been broken off (Hoffa).

IV. Divergent Dislocation of both Bones of the Forearm.—In very rare cases the bones of the forearm are dislocated in different directions—e. g., the ulna backward and the radius forward (Fig. 692). Bisell and Guersant observed divergent lateral dislocation in which the head of the radius lay upon the outer and the olecranon upon the inner condyle. The bones of the forearm were broken in the middle in both cases. For the symptomatology and the treatment of divergent

dislocations the reader is referred to dislocations of the radius and the ulna.

V. Dislocation of the Ulna Alone.—Isolated dislocations of the ulna occur only in a backward direction. In the rare complete backward dislocation of the ulna there is always, no doubt, a fracture of the radius or the lower end of the humerus. The interosseous ligament and the annular and internal lateral ligaments are severely torn. The coronoid process lies in the olecranon fossa and the radius is, as has been said, either fractured or likewise displaced somewhat in a backward or forward direction (Fig. 692). In incomplete backward dislocation of the ulna the coronoid process rests upon the trochlea, so that the articular surface of the olecranon projects more or less posteriorly.

In complete backward dislocation of the ulna there is essentially the same deformity as in backward dislocation of both bones of the forearm (see pages 581, 582), with the single difference that the radius remains in its normal place. The forearm is more or less flexed, is sharply pronated, and its axis is directed somewhat inward, so that it forms an obtuse angle with the inner border of the humerus.

The symptoms are essentially the same in incomplete dislocations of the ulna, except that the olecranon is not so prominent posteriorly.

Reduction is accomplished in much the same way as in backward dislocation of both bones (see page 582), or by simple extension of the forearm with direct pressure upon the olecranon. Another good procedure is to abduct the forearm, rotate the humerus outward, and then flex the elbow quickly.

VI. Dislocation of the Radius Alone.—The radius may be dislocated forward, backward, and outward.

(a) *Dislocation of the Radius Forward.*—This most frequent dislocation of the radius arises usually from a thrust or a blow upon the upper end of the radius from behind, or, indirectly, from a fall upon the hand when the forearm is outstretched and pronated, or, finally, from violent pronation, when, for example, children are lifted up by the hand, and sometimes also from excessive supination (Radestock). The dislocation is frequently incomplete—e. g., in case of violent pronation. Incomplete dislocations may also arise in the lower radio-ulnar articulation from the action of the same violence. In complete forward dislocation of the radius its head rests on the anterior edge of the external condyle of the humerus (Fig. 693), and is here to be seen and felt as an abnormal fulness. The head of the radius is absent at the normal place, and in its place an abnormal depression is felt, which contains the edge of the articular process of the ulna. The forearm is slightly flexed and pronated. Flexion is possible to a slight degree

only, as the head of the radius rests upon the humerus. The dislocation is often complicated by fracture of the upper third of the ulna (Fig. 693), especially in case of a blow upon the ulna from behind, whereby the latter breaks and the radius is driven forward. The coronoid process of the ulna may be

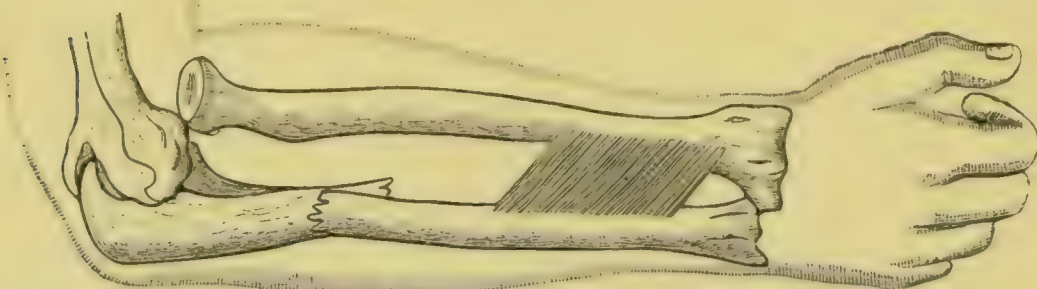


FIG. 693.—Forward dislocation of the radius with fracture of the ulna (diagrammatic).

torn away by traction of the annular ligament. In other cases the annular ligament is ruptured and the coronoid process remains intact.

In incomplete dislocation there is no pronounced deformity. According to Streubel, the posterior part of the capsule is incarcerated between the head of the radius and the capitellum, the forearm is pronated, and all attempts at supination are painful. In some supposed incomplete forward dislocations of the head of the radius the real location of the trouble is in the lower radio-ulnar articulation of the wrist joint (see § 301).

(b) *Dislocation of the Head of the Radius Backward*.—This rare dislocation arises usually from a fall upon the hand or from violent supination. The head of the radius rests upon the posterior surface of the external condyle of the humerus, and can be easily felt here when the forearm is rotated. The forearm is supinated and slightly flexed, and forms with the upper arm an angle which opens outward. The radial side of the forearm is shortened.

(c) *Dislocation of the Head of the Radius Outward*.—This very rare dislocation probably arises secondarily from a forward or backward dislocation (Hamilton, Roser). It is more frequently combined with fracture of the ulna in its upper third, in consequence of the action of direct violence upon it, the head of the radius being forced outward by the same injury, as in forward dislocation of the radius (Fig. 693). In every case of fracture of the ulna in its upper third one should have in mind a simultaneous dislocation of the radius outward or forward. In case of outward dislocation of the head of the radius, the same is to be felt at the outer border of the external condyle of the humerus. The radial side of the slightly flexed forearm is shortened and forms with the humerus an angle that opens outward.

In all dislocations of the head of the radius, its abnormal position is best recognised by rotating the forearm, both in a flexed and in an extended position.

The prognosis of dislocations of the head of the radius alone is not favourable, because the retention of the head in its normal place is difficult and recurrences easily occur in consequence. Reduction may be made difficult in a number of ways—e. g., by the interposition of portions of the capsule or of the torn annular ligament, by the tension of the intact portion of the capsule, by fragments of cartilage or bone which are broken off from the head of the radius, or by complete intracapsular fracture of the head of the radius, etc. In all dislocations of the head of the radius which are not reduced, complete flexion, extension, and rotation of the forearm are prevented.

Treatment of Dislocations of the Head of the Radius.—Forward dislocations of the same are reduced by traction upon the flexed and supinated forearm and by direct pressure upon the dislocated head. Interposition of the annular ligament sometimes proves an obstacle to reduction.

In case of backward dislocation of the head of the radius, reduction is accomplished by traction upon the hyperextended and pronated forearm, with direct pressure upon the head from above and behind.

In outward dislocations of the head of the radius, the latter is lifted from the external condyle of the humerus by ulnar flexion of the forearm, and the head is pressed downward and inward.

Should the reposition or retention of the dislocated head of the radius prove impossible, one will perform arthrotomy with antiseptic precautions, remove the obstacle to reduction, and, if necessary, close the tear in the capsule by suture. In suitable cases the head of the radius should be exposed and resected, use being made of a longitudinal incision along the radius by which the musculo-spiral nerve is best avoided.

The after-treatment of all dislocations of the elbow joint consists in immobilizing the latter in a flexed position for about a fortnight by means of a plaster-of-Paris or other splint. Use is then made of careful exercise of the joint, massage, and electricity. In cases of longer standing, also, reduction should be attempted with the patient under an anæsthetic; but there is usually little prospect of successful reduction after the dislocation has lasted for a number of weeks. If reduction is no longer possible, the joint should be brought into a position in which it can be used (right-angle), or, better, the function of the elbow improved by arthrotomy or resection.

Partial resection is usually sufficient in old dislocations—i. e., only those projections of bone are resected which interfere with reduction.

Habitual dislocations are very rare, and are treated essentially like those of the shoulder (page 525). The best way is to open the joint and try to restore the normal structure of the same.

Congenital dislocation of the elbow is rare, and, like every congenital dislocation, to be regarded as a malformation. Congenital dislocation of the radius behind the external condyle of the humerus, for example, with simultaneous deformity of the articular portion of the humerus and the ulna, has been described by Dupuytren, Sandifort, Adams, Froriep, and Hertskowits. The anomalies of position of the upper end of the radius in consequence of inhibition of the longitudinal growth of the ulna are of special interest (Humphry). In such cases the upper end of the radius is pushed upward on the anterior or lateral aspect of the humerus.

§ 290. **Diseases of the Elbow Joint.**—The different forms of acute and chronic inflammation, as described in detail in *Principles of Surgery*, §§ 113 to 119, are observed in the elbow joint. Inspection and palpation of the posterior part of the elbow on both sides of the olecranon are especially important in the diagnosis of diseases of this joint. All pathological changes in the joint are first demonstrable here—e. g., abnormal fulness and swelling. The radio-humeral articulation and the head of the radius can easily be felt in front of and below the external condyle of the humerus, upon rotation of the forearm about its longitudinal axis (pronation and supination). The radio-ulnar articulation can also be palpated by rotating the radius about the ulna. In all diseases of the elbow joint proper, flexion and extension are restricted first. In case of an effusion within this joint, the latter is flexed, because the capacity of the joint is greatest in this position. Contraction of the biceps, which is mainly of a reflex nature, is a very early symptom of inflammation of the elbow joint.

Hæmarthrosis (effusion of blood in the joint) and acute serous synovitis are observed especially in subcutaneous and open injuries of the joint. Acute synovitis occurs also in connection with acute articular rheumatism and in gonorrhœa. Acute synovitis following wounds of the joint often becomes suppurative if it does not receive aseptic treatment, especially after gunshot wounds.

For a more detailed description of acute joint inflammations see *Principles of Surgery*, page 658.

The treatment of subcutaneous hæmarthrosis consists in massage and systematic movements of the joint. In case of subcutaneous acute synovitis the joint is placed at rest (sling or elevated position upon a splint) and ice is employed. After the pain has subsided, massage and movements of the joint are begun. In acute articular rheumatism and in acute gonorrhœal arthritis, immobilization with the arm flexed

and midway between pronation and supination is to be recommended. Massage should not be employed. In case of acute suppurative inflammations following a penetrating wound of the joint the wound is to be enlarged if necessary, other incisions are to be made, and the joint drained. The drainage-tube or gauze should always be placed in the most dependent part of the joint—e. g., in case of elevation of the latter, between the internal condyle of the humerus and the olecranon. In every case of suppurative inflammation of the elbow joint the latter is to be dressed antiseptically and immobilized by a splint (see Principles of Surgery, page 665). Septic inflammations of the joint in particular must be treated by irrigation of the joint with 1-to-1,000 bichloride. I avoid irrigation of the joint as far as possible in the after-treatment. Attention should always be paid to possible burrowing of pus. In gunshot wounds, with comminution of the articular surfaces, primary resection of the involved surfaces, or, it may be, merely the extraction of the completely detached splinters of bone, is indicated (see § 292, page 595, Technique of Resection of the Elbow). For a detailed statement of the symptomatology and the treatment of acute inflammations of joints the reader is referred to Principles of Surgery, page 658 ff.

Of chronic inflammations of the elbow joint I first mention the synovitis due, for example, to sprains and fractures of the joint, tuberculosis, syphilis, gonorrhœa, and acute articular rheumatism. The increased amount of fluid within the joint is detected mainly behind and on both sides of the olecranon. Every case of chronic effusion which is not conditioned upon microbic infection, as in tuberculosis, syphilis, and gonorrhœa, is treated by massage, by compression of the joint from time to time with elastic bandages, and by methodical movements of the joint. In arthritis due to microbic infection, immobilization, combined, if necessary, with puncture and aspiration or with incision (arthrotomy), is indicated. A proper constitutional treatment is often sufficient in case of syphilis (mercury, inunctions, iodide of potassium). In tubercular effusion the injection of from two to five grammes of ten-per-cent sterilized iodoform-glycerin, or ten-per-cent iodoform oil, every two, three, or four weeks, is especially useful. I move the joint after each iodoform injection, in order to bring the injected solution in contact with the entire synovial membrane.

Tubercular arthritis begins sometimes in the bone and sometimes in the synovial membrane. In the latter case the effusion is more likely to be marked. In case of bony origin, there is noticeable enlargement of the involved bone, especially of the lower end of the humerus or of a condyle. The course of tubercular inflammation of the elbow joint is very slow, and is characterized by gradual flexion

and diminished mobility, with corresponding destruction of the joint. In the later stages there is usually a diffuse swelling of the entire region of the joint, with fistulæ, and the joint becomes loose or, on the other hand, more and more stiff.

The treatment of tubercular arthritis of the elbow consists at first in immobilizing the joint in various positions, and in the injection of sterilized ten-per-cent iodoform-glycerin or iodoform oil every two, three, or four weeks, from two to five grammes being used, according to the severity of the case. If the object is not accomplished in this way, arthrotomy with scraping out, or, it may be, resection of the diseased portion of the joint combined with excision of the diseased capsule (arthrectomy or synovectomy), is indicated. Typical resections are to be made as seldom as possible. On the contrary, as much of the bone as possible should be retained. The joint is opened, according to the location of the disease, either by an incision over a condyle or by the typical resection-incision of Langenbeck, Hueter, or Ollier (see § 292, page 595, Resection of the Elbow). The fistulæ often indicate the place at which the joint should be opened. Circumscribed foci in the bone—e. g., in the humerus—may be scraped out outside the joint and then allowed to heal under a blood clot. A general strengthening treatment is always of great importance. See also Principles of Surgery, page 420 ff, and page 679 ff.

Syphilitic arthritis of the elbow is by no means rare. It occurs not infrequently among children in cases of hereditary syphilis. For the symptomatology of syphilitic inflammations of joints, the reader is referred to Principles of Surgery, page 682. The early forms have the characteristics of a serous synovitis, while in the later stages of syphilis we have to do usually with gummata or proliferation and induration of the connective tissue of the synovial membrane. In all cases in which it is doubtful whether syphilis or tuberculosis exists, a trial should be made with inunctions or of iodide of potassium. If there is improvement, we have to do with syphilis. The treatment of syphilitic joint inflammations should be both local and constitutional (see Principles of Surgery, page 433, Syphilis).

For the neuropathic diseases of the bones of the elbow and the elbow joint attending syringomyelia, see Principles of Surgery, page 695.

Arthritis deformans of the elbow very frequently results from fractures through the joint. Severe deformation of the joint, especially of the bones, fibrillation of the cartilage, the formation of free bodies in the joint, marked thickening of the capsule, etc., not infrequently ensue. The course is usually very chronic, but I have also seen cases with a rather acute or subacute course in which severe arthritis deformans ensued in a comparatively short time—e. g., after a fracture of the olecranon that had not united. The arthritis deformans may be brought to a standstill in such cases by cure of the pseudarthrosis of the olecranon by suture.

The treatment of arthritis deformans consists in massage, systematic

movements of the joint, baths, hydropathic remedies, the use of hot springs (Gastein, Wiesbaden, Teplitz, etc.), resection, the removal of a definite cause (movable bodies in the joint, pseudarthrosis), etc.

Gouty inflammation of the elbow joint (arthritis urica) is observed mainly as peri-arthritis urica with corresponding circumscribed swellings. For the symptomatology and treatment of gout, see Principles of Surgery, pages 663 and 666.

Tumours of the elbow are not very frequent. Enchondromata, exostoses, and sarcomata occur in the bones. One also observes epitheliomata of the skin and neuromata of the ulnar nerve. These tumours are extirpated according to general rules. Neuromata of the ulnar nerve can usually be enucleated, with preservation of the continuity of the nerve.

The so-called supracondyloid process, a congenital formation, which may also be hereditary, is an exostosis, located several centimetres above the internal epicondyle, and is hook-shaped below; it forms the point of origin of the pronator teres. The brachial artery and the accompanying nerves run behind this process.

§ 291. **Contraction and Anchylosis of the Elbow.**—Cicatricial contractions of the elbow occur especially after injuries. If there is simply a cicatricial contraction of the skin, this can be easily overcome by division or excision of the cicatrix and covering the defect with skin-grafts, or with a pedunculated flap from the upper arm, the forearm, or the chest. Deeper cicatricial bands also are to be carefully divided. We have already mentioned on page 567 the use of pedunculated flaps from the chest for covering skin defects in the region of the elbow, as well as the use of extension, after Schede, for the purpose of stretching the cicatrices. In all cases of injury in the region of the elbow with skin defects, one should, by way of prophylaxis, guard against the development of contractions by placing the arm in a proper extended position or by plastic operations.

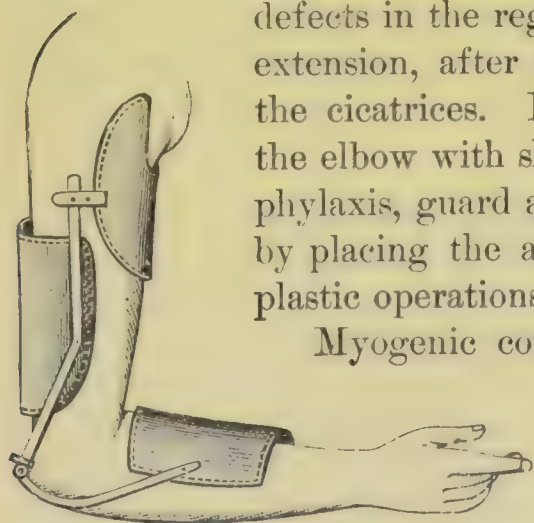


FIG. 694.—Bidder's splint for gradual extension of an ankylosed elbow.

Myogenic contractures arise from injuries and diseases of the muscles, most frequently of the biceps, especially from gummatous infiltration of the same (myositis syphilitica), from disturbances in innervation, spasm of the biceps, etc. Stromeyer had to resort to tenot-

omy for chronic spasm of the biceps. The treatment of myogenic (traumatic) contractures is essentially the same as that of the above-mentioned cicatricial contractions of the skin. Massage, active and passive movements, weight extension, and the use of splints with an adjustable hinged joint (see Fig. 694) are likewise to be recommended.

Arthrogenic contractures, with corresponding partial or complete ankylosis of the joint, are rather frequent, and result from intra-articular causes—e. g., from shrinkage of the capsule, from fibrous or bony adhesions, from malunion of fractures of the articular surfaces, etc. (see also *Principles of Surgery*, page 704).

The treatment of arthrogenic contractures is directed mainly against their cause. The attempt should be made to overcome shrinkage of the capsule and fibrous adhesions by means of massage, active and passive movements, and by forcible correction of the contraction, with the patient under an anæsthetic, or, it may be, by partial or complete resection of the joint. One can secure a movable articulation by resection of the elbow, or at least bring the joint into a position (right-angled) in which it can be used. Ankylosis with the arm extended interferes seriously with the use of the latter, and should always be guarded against or be changed into a right-angled ankylosis by resection, it may be, of the joint. In case of complete bony ankylosis one may secure a movable joint by resection as well as by simply dividing the bridge of bone with a saw, corresponding to the line of the joint (Defontaine).

For the gradual correction of a contracture of the elbow joint otherwise than by operation, the use of suitable splints with an adjustable hinged joint, as represented in Fig. 694, is to be recommended. Such splints may be imitated by using a water-glass or a plaster-of-Paris splint and cutting out the portion about the joint, and then applying shanks with elastic traction, either behind or in front, depending upon the nature of the contraction, or inserting pieces of cork between the halves of the splint.

Among other contractions of the elbow, mention should be made of the so-called cubitus varus and cubitus valgus. By cubitus varus is understood an abnormal ulnar flexion and pronation of the forearm, in consequence of rhachitis or from fractures, and especially separation of an epiphysis, with shortening of the inner condyle and a corresponding change in the axis of the ulna (Nicoladoni). In cubitus valgus we have to do with an excessive supination or radial flexion of the forearm. The latter may be hyperextended in consequence of relaxation of the capsule and the articular ligaments, and in connection with this hyperextension the olecranon sometimes slips onto the internal condyle, and the radius may be dislocated backward. Congenital cubitus varus and cubitus valgus usually give no occasion for therapeutic measures. In case of severe acquired cubitus valgus or cubitus varus, in consequence of malunion of a fracture, for example, the deformity may be overcome, if necessary, by osteotomy.

§ 292. **Resection of the Elbow** is indicated in compound fractures and dislocations, in old irreducible dislocations, in gunshot injuries, in

suppurative, tubercular, and syphilitic arthritis, and in ankylosis in a position of flexion or extension. The resection is either complete or partial. In the former all the articular surfaces are removed, while in the latter some portions are preserved. When diseased, the capsule is sometimes completely excised (arthrectomy). Since the adoption of antiseptic methods in surgery, complete resections of the joint are avoided, and as much of the bone is preserved as possible. If the periosteum is sound, it is left (subperiosteal resection). For the sake of a better functional result, the muscular insertions on the external and internal condyles of the humerus and on the olecranon (triceps), and also the insertions of the biceps and brachialis anticus muscles, are to be preserved intact as far as possible. Injury of the ulnar nerve in its groove on the internal condyle of the humerus can easily be avoided.

Of the different methods of resection of the elbow joint, those of Langenbeck and Hueter and the modifications made by König, Jeffray, Ollier, and Vogt deserve special mention.

1. Resection of the Elbow Joint, after Langenbeck, by a Single Longitudinal Incision.—The skin incision, which is eight or ten centimetres long, runs over the extensor side of the slightly flexed elbow, somewhat to the inner side of the middle of the olecranon (Fig. 695, 1). It begins three or four centimetres above the tip of the olecranon and ends on the inner border of the ulna. The skin, muscles, tendon of the triceps, and periosteum are divided at one stroke. The inner half of the tendon of the triceps muscle is next detached from the bone, together with the periosteum, by means of an elevator, or a thin piece of the cortex is removed with the chisel. The soft parts covering the internal condyle are then detached from it by means of slightly curved cuts with the scalpel, which are made close to one another and always directed against the bone. Injury of the ulnar nerve in its groove on the internal condyle is especially to be avoided, and this is most surely done by use of the curved longitudinal incisions. Oblique cuts are not permissible. The ulnar nerve is pushed back, together with the soft parts, from the internal condyle, and is not seen at all. Nussbaum made the skin incision over the ulnar nerve, exposed the latter, and had it drawn to one side with a retractor. The internal epicondyle is finally laid free by the slightly curved longitudinal cuts, the origins of the flexor muscles and the internal lateral ligament being detached, and strict care taken to preserve the connection of



FIG. 695.—Resection of the elbow joint: 1, after Langenbeck; 2, bilateral incision after Huetter-Vogt.

these parts with the periosteum. One can also chisel away the apex of the internal epicondyle with its ligamentous and muscular insertions, so that the latter remain connected with the bone.

The detached soft parts on the inner side of the elbow are now allowed to fall back into their normal place, the outer portion of the tendon of the triceps muscle is separated from the olecranon, together with the periosteum, in precisely the same way, and the external condyle is exposed, like the internal one, by means of incisions made close to one another and directed against the bone. One may here also chisel away the external epicondyle with the insertions of the external lateral ligament and the extensor muscles. The ends of the bone are now forced out of the wound by hyperflexion of the joint and, so far as they are diseased, removed with the saw or chisel or with a sharp spoon. If it is necessary to resect the ulna below the coronoid process, the uppermost fibres of the brachialis anticus muscle are detached from the coronoid process and the connection of the tendon with the periosteum of the ulna is preserved. After the removal of the diseased or injured portions of the bone the synovial membrane is thoroughly excised, if necessary, with scissors and forceps.

2. Resection, after Hueter, by Means of Two Longitudinal Incisions (Fig. 695, 2).—This is an excellent method, as it permits an inspection of the whole joint. The internal epicondyle is first exposed by a longitudinal incision from two to four centimetres long, and the internal lateral ligament is divided by curved incisions made around the base of the epicondyle. It is a better plan here also to chisel away the internal epicondyle with its ligamentous and muscular insertions. The ulnar nerve, which lies on the posterior surface of the internal epicondyle, should be carefully avoided. A longitudinal incision from eight to ten centimetres long is then made on the outer side of the joint over the external condyle and the head of the radius. After the soft parts have been drawn apart with retractors the external lateral ligament and the annular ligament of the radius are divided, and the head of the radius is exposed and removed with a metacarpal saw or a chisel. The external condyle of the humerus is then laid free subperiosteally by incisions directed against the bone and by means of a periosteal elevator, or, better, is detached with the chisel, together with the insertions of the ligaments and muscles. The articular ends of the bones are dislocated by forcible lateral flexion of the forearm, and first the articular surface of the humerus and then that of the bones of the forearm is resected, as the extent of the disease may require.

3. Resection, after Jeffray, Ollier, and P. Vogt, by Means of Two Longitudinal Incisions, consists of the following steps: 1. A longitu-

dinal incision eight to ten centimetres long is made on the radial side over the external condyle and the head of the radius, and the latter is sawn off just as in Hue-ter's method. 2. The external epicondyle, with the insertions of the external lateral ligament and the extensor muscles, is detached with the chisel, and the external condyle is exposed. 3. A longitudinal incision is made on the ulnar side, likewise from eight to ten centimetres long, over the internal epicondyle, and the latter is chiselled away, together with the insertions of the ligaments and the muscles. The exposure of the lower end of the humerus is then completed. 4. The articular end of the humerus is sawn off *in situ*, the insertion of the triceps tendon is chiselled away, and the olecranon is sawn off. Ollier's bayonet-shaped incision (Fig. 696) is also useful.



FIG. 696.—Ollier's bayonet incision for resection of the elbow joint.

Arthrectomy (Synovectomy), after Tiling.—If the capsule alone is diseased in tuberculosis of the elbow joint and the bones are sound, synovectomy, after Tiling, may be undertaken in the following manner: A curved incision

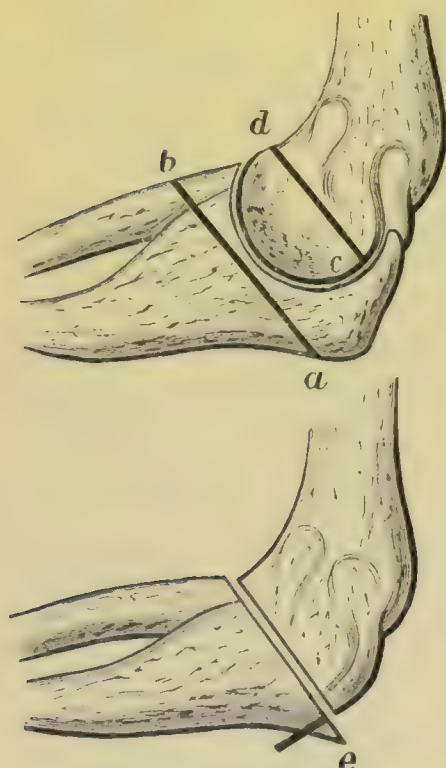


FIG. 697.—Oblique saw lines in complete resection of the elbow joint.

opening downward is made on the posterior aspect of the joint. It begins beneath the radio-humeral articulation, divides the tendon of the triceps muscle transversely three or four finger breadths above the tip of the olecranon, and then passes downward over the posterior surface of the internal epicondyle along the ulnar nerve. The skin and the other soft parts are divided in layers, and the ulnar nerve is displaced inward out of its groove. After the flap of soft parts has been dissected away from the periosteum, and the two epicondyles with their ligamentous and muscular insertions have been separated with the chisel and displaced forward and downward, the joint can be opened widely enough to permit the removal of the entire synovial membrane. After excision of the synovial membrane the articular ends of the bone are replaced, the epicondyles are fixed in their normal position again by sutures or nails, the triceps stitched together, and the wound drained and sutured. After the wound has

healed by primary union, movements and massage of the joint must be begun as soon as possible—after ten days, for example—as otherwise ankylosis easily ensues, more readily, in fact, than after resection of the articular ends of the bone.

In order to effect the reposition of old irreducible dislocations of the elbow joint, Trendelenburg and Völeker performed temporary resection of the olecranon. Trendelenburg's method is as follows: The olecranon is exposed by means of a curved incision at its base with



FIG. 698.—Esmarch's arm splint for resections of the elbow.

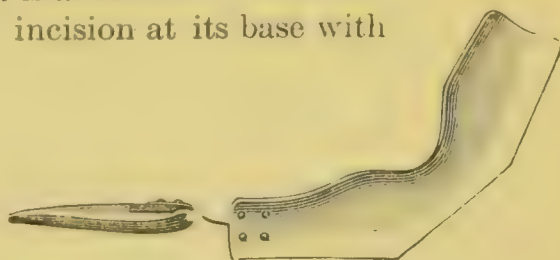


FIG. 699.—Volkmann's arm splint (supination splint).

the convexity upward, divided with the chisel, and turned upward. After reduction of the dislocation and inspection of the joint, the olecranon is again united with the ulna by a few sutures.

In order to avoid a loose joint after complete resection of the elbow and to secure a firm bony ankylosis, it is a good plan to saw off the articular ends of the bone in an oblique direction, as shown in Fig. 697 (C. Zatti). The projecting edge of bone on the ulna (Fig. 697, *e*) is then removed.

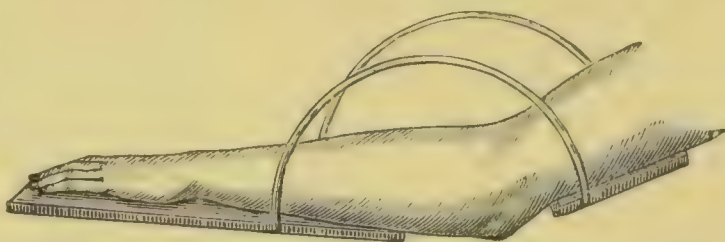


FIG. 700.—Esmarch's double splint for resections of the elbow.

After-treatment of Resections of the Elbow.—After the operation has been completed the wound is drained

and sutured, or it is left open and packed with iodoform gauze, especially in case of extensive suppuration. An antiseptic protective dressing is then applied with the arm slightly flexed and a splint, such as is represented in Figs. 698, 699, or 700, added. The after-treatment, which is so important in cases of resection of a joint, begins in the third or fourth or fifth week, according

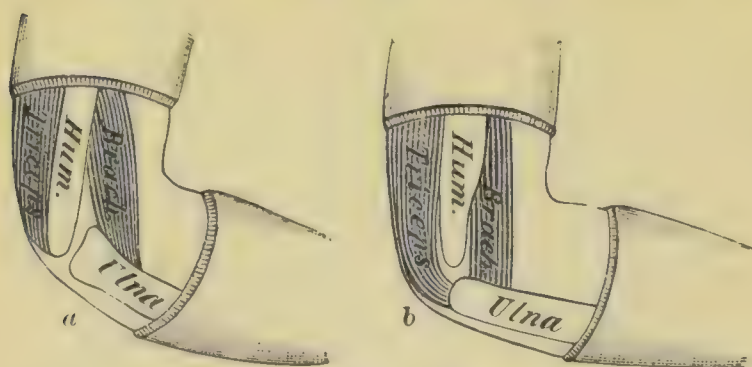


FIG. 701.—*a*, incorrect position of the ends of the bones after resection of the elbow; *b*, correct position.

to the nature of the case, after the wound has healed, and aims to restore as far as possible the function of the joint by means of passive movements, massage, electricity, baths, etc. Partial resections, of course, give, generally speaking, better functional results than complete resections.

A loose joint is not infrequent after the latter. Roser has properly called attention to the fact that a loose joint is especially likely to follow complete resection when the humerus is not sufficiently supported by the bones of the forearm; in other

words, when the resected ends of the ulna and radius lie in front of the humerus (Fig. 701 *a*). Fig. 701 *b* represents the desirable position of the resected bones. If a loose joint at the elbow exists, use must be made of suitable braces or splints. Socin's splint is very serviceable (Fig. 702), as is also that

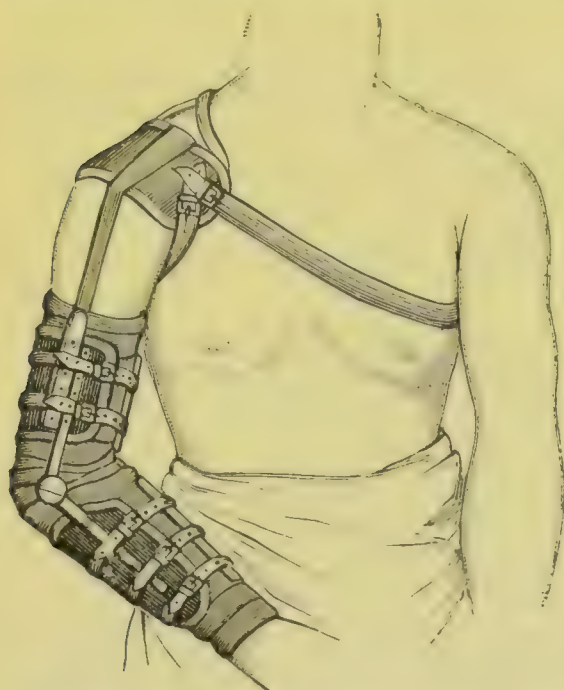


FIG. 702.—Socin's splint for loose elbow joint.

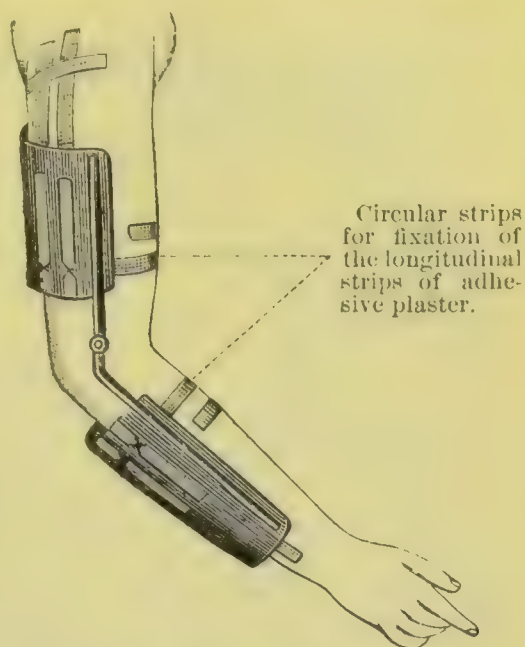


FIG. 703.—Bidder's splint for loose elbow joint.

of A. Bidder (Fig. 703). Bidder's splint is fastened to the arm by strips of adhesive plaster. The bones of the forearm are drawn toward the humerus by longitudinal strips of plaster.

If there is a probability that ankylosis will follow resection of the elbow, the forearm should be kept flexed at about a right angle and somewhat pronated.

The earlier statistics regarding mortality and the results following resections of the elbow joint in peace and war—e. g., those of Saltzmann, Gurlt, Otis, Dominik, and others—have now only a historical value. The results have become much better under aseptic methods of operating. According to the statistics of Middeldorpf (1886), taken from times of peace, the percentages of firm new joints, ankylosis, and loose joints are as sixty to twenty-five to fifteen. The statement of Middeldorpf is also of special interest, to the effect that after nine and a half years about one fifth of all patients operated upon for tuberculosis of the elbow joint, amputation included, had died of tuberculosis.

§ 293. **Amputation at the Elbow** is performed either by the circular or the flap method.

In the circular method the skin is divided down to the fascia about four finger breadths below the condyles of the humerus. The cuff of skin is dissected up from the fascia as far as the condyles and reflected. The joint is then opened by means of a transverse incision with an amputation knife upon the flexor side of the extended forearm. The

external lateral ligament is divided above the head of the radius or just below the external condyle, and the radio-humeral joint is thus opened. The internal lateral ligament is divided in the same way below the

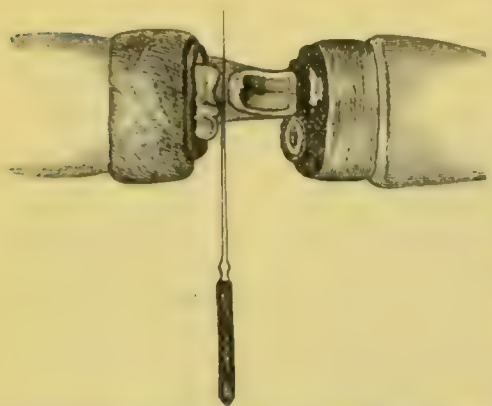


FIG. 704.—Amputation at the elbow by the circular method.

internal condyle. The forearm is now held only by the tendon of the triceps muscle, which is divided above the tip of the olecranon (Fig. 704). The brachial artery and the anastomotic branches around the elbow are tied, and the nerves are drawn out with forceps and cut off short.

The best method of performing a flap amputation is to cut a long anterior and a short posterior flap (Fig.

705). The anterior curved incision begins about one or one and a half finger breadths beneath one condyle and ends at a like distance from the other condyle. The long semicircular skin-flap thus formed is dissected from the fascia and reflected upward. On account of the great power of retraction possessed by the skin at the bend of the elbow, this flap should be made as long as possible. A second shorter skin-flap is cut on the posterior aspect of the joint, and the further course of the operation is then the same as in circular amputation.



FIG. 705.—Amputation at the elbow by the flap method.

The formation of a flap of skin and muscle by transfixion is not to be recommended.

It is a good plan to remove the irregularly formed lower articular end of the humerus and extirpate the capsule of the joint (transcondyloid amputation of the arm).

For the technique of bandaging the upper arm and the elbow the reader is referred to Principles of Surgery, §§ 50-55.

CHAPTER XXXI.

INJURIES AND DISEASES OF THE FOREARM AND THE WRIST.

Injuries of the soft parts of the forearm (muscles, tendons, nerves, and vessels).—Ligation of the radial and ulnar arteries.—Aneurisms.

Fractures of the forearm.—Fractures of both bones.—Fractures of the ulna.—Fractures of the radius.—Anatomy of the different articulations of the carpus.—Contusions, sprains, and wounds of the wrist.—Dislocations of the radio-carpal joint, of the inferior radio-ulnar joint, and of the carpal bones.—Fractures of the carpal bones.

Inflammatory processes and other diseases of the soft parts of the forearm and the wrist.—Lymphangitis, phlebitis, erysipelas, cellulitis.—Diseases of the tendons, the tendon sheaths, and the bursæ of the forearm and the carpus.—Dry tenosynovitis.—Serous tenosynovitis.—Tubercular tenosynovitis.—Gummatous (syphilitic) tenosynovitis.—Rice bodies in the tendon sheaths.—Acute and chronic inflammations of the sheaths and synovial sacs of the flexor tendons.—Ganglion.—Inflammations of the bones of the forearm.—Tumours.—Deformities.—Diseases of the wrist joint and the carpus.—Amputation of the forearm.—Amputation at the wrist.—Resection of the wrist and the carpus.

For the technique of bandaging the forearm and the wrist, see Principles of Surgery, §§ 50-55.

§ 294. **Injuries of the Muscles and Tendons of the Forearm.**—Complete transverse ruptures of the entire belly of a muscle are rare. In case of complete rupture the ends of the muscle separate from one another in proportion to their elasticity. The ends are best united in such cases by means of a double row of interrupted catgut sutures, or the catgut suture is carried transversely through each stump of the muscle, passing in and out several times (Wölfler). A few interrupted sutures should also be passed through the intermuscular connective tissue, in order to relieve the tension upon the line of suture of the muscle, and to prevent the stitches from pulling out. A suitable position of the arm is also a help in the same direction—that is, in case of injury of the flexors the elbow and the hand should be flexed, and in case the extensors are injured the elbow and the hand should be extended. The elbow and the hand are then immobilized in this position by some form of splint. Defects in the muscle are restored by the formation of pedunculated flaps from the stumps of the same, by the interposi-

tion of threads of catgut (Gluck), or by grafting the distal end of the tendon into a neighbouring tendon (Tillaux, Duplay). The grafting of a piece of muscle from an animal is never successful. After healing has taken place there remains at the site of suture, even after primary union, a fibrous cicatrix, a tendinous intersection of the muscle, as it were, whereby the function of the muscle is not impaired. The most serious functional disturbances arise from extensive contusions with subsequent suppuration of the substance of the muscle.

The same principles apply in the treatment of subcutaneous or open divisions of the tendons, whether fresh or of long standing. Here also, in case of fresh injuries, the best way is to unite the ends of



FIG. 706.—Teno-
plasty for de-
fect in a tendon.

the tendon with catgut in the above-described manner after Wölfler, and to relax the tendon by giving the hand and the elbow a suitable position. The stumps may furthermore be attached to the adjacent tissue by means of a number of interrupted sutures* or a continuous suture. If there is a defect in the tendon, a pedunculated flap is formed from one stump, as represented in Fig. 706 (Hueter, Czerny, the author), or the defect is made good by implanting a tendon from an animal or threads of catgut or silk, after Gluck, or in severe cases by grafting the distal stump of the tendon into a neighbouring tendon which has a similar func-

tion. Duplay sutured the distal stump of the extensor longus pollicis into a slit in the extensor carpi radialis. In case of extensive defects in the muscles and tendons, one could also unite the latter by resection of a piece from the bones of the forearm (Löbker). The ends of the tendon are sometimes adherent to the skin, and the continuity of the tendon is thereby indirectly restored.

In old cases of division of a tendon the stumps are sought out, dissected free if necessary, freshened, and then united in the above manner. The proximal end of the tendon is sometimes displaced a considerable distance upward. Various methods may be adopted for finding the same—e. g., opening the sheath and drawing the stump down with a tenaculum, pressing or kneading the muscles downward with the hand, or applying an elastic bandage from above downward. Madelung's suggestion is a very good one—that an incision be made at the place where the stump is supposed to be and then to push or draw the end of the tendon forward through its empty sheath.

In case of injury to several tendons, great care must be taken that the right stumps are united. All operations on the tendons are to be performed under strict aseptic rules, or otherwise suppuration and

death of the tendons ensue only too easily. Too many sutures through the stump also easily occasion necrosis of the tendon.

For the technique of lengthening tendons, after Sporon, see *Principles of Surgery*, page 467.

§ 295. **Nerve Injuries of the Forearm.**—Among injuries of the nerves in the forearm, those of the median, ulnar, and musculo-spiral are very frequent, especially near the wrist joint. Every complete division of the three nerves named is characterized by a typical functional disturbance of the hand. The higher the injury of the nerves lies, the greater the disturbance in the function of the muscles of the forearm. The muscles of the upper arm (the triceps and the outer portion of the brachialis anticus) are affected only in case of paralysis of the musculo-spiral nerve high up. The ulnar and median nerves give off no branches to the muscles of the upper arm.

1. **Injury of the Median Nerve.**—The median nerve in the upper arm accompanies the brachial artery, then at the elbow passes to the inner side of the artery beneath the bicipital fascia, then runs behind the pronator teres, where it lies between the flexor sublimis digitorum and the flexor profundus digitorum muscles, and finally enters the palm of the hand, where it divides into four branches, one for the thumb and thenar eminence, and one each for the first, second, and third interspace between the metacarpal bones. The median nerve supplies all the muscles of the flexor side of the forearm with the exception of the flexor carpi ulnaris and the ulnar portion of the flexor profundus digitorum—that is, the pronator teres, the flexor carpi radialis, the palmaris longus, the flexor sublimis digitorum and profundus (with the exception of the ulnar portion, which is supplied by the ulnar nerve), the pronator quadratus, the flexor longus pollicis, the muscles of the thenar eminence (adductor, flexor brevis, and opponens pollicis), with the exception of the adductor, which is supplied by the ulnar nerve and the deep head of the flexor brevis pollicis, and finally the first three lumbricales.

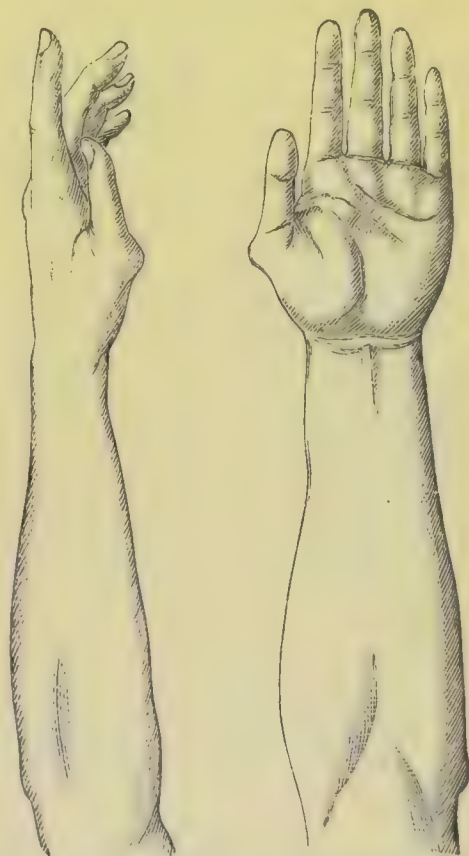


FIG. 707.—Position of the hand in paralysis of the median nerve.

The functional disturbances in consequence of paralysis of the median nerve are therefore the following (Fig. 707): Flexion of the second phalanx of all the fingers is impossible, as is that of the third phalanx of the forefinger and the middle finger. The functional dis-

turbance of the thumb is especially characteristic. All the muscles of the thenar eminence are paralyzed with the exception of the adductor pollicis, which is supplied by the ulnar nerve and the deep head of the flexor brevis pollicis. The thumb, therefore, can not be flexed or abducted and can not be brought into contact with the other fingers. It remains in extension and rests against the forefinger, much as in the monkey's hand (Fig. 707). Flexion of the first phalanx and extension of the last two phalanges are performed by the interossei muscles (ulnar nerve). The higher up the seat of the paralysis or the division of the nerve is, the more of the above-mentioned muscles of the forearm on the flexor side are paralyzed, with the exception of the flexor carpi ulnaris, which is supplied by the ulnar nerve, and the ulnar portion of the flexor digitorum communis profundus. The last three fingers can therefore still be partially flexed, because the ulnar portion of the flexor digitorum profundus muscle is supplied by the ulnar nerve.

The disturbance of sensation in the skin of the hand attending paralysis of the median nerve is confined approximately to the dark portion of the hand as represented in Fig. 708. As is well known, the

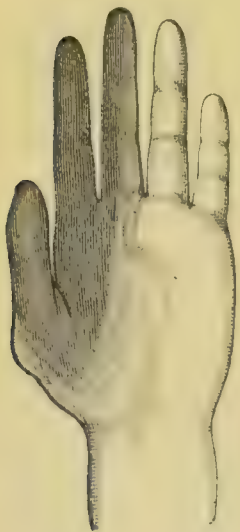


FIG. 708.—Area of the sensory disturbance in paralysis of the median nerve.

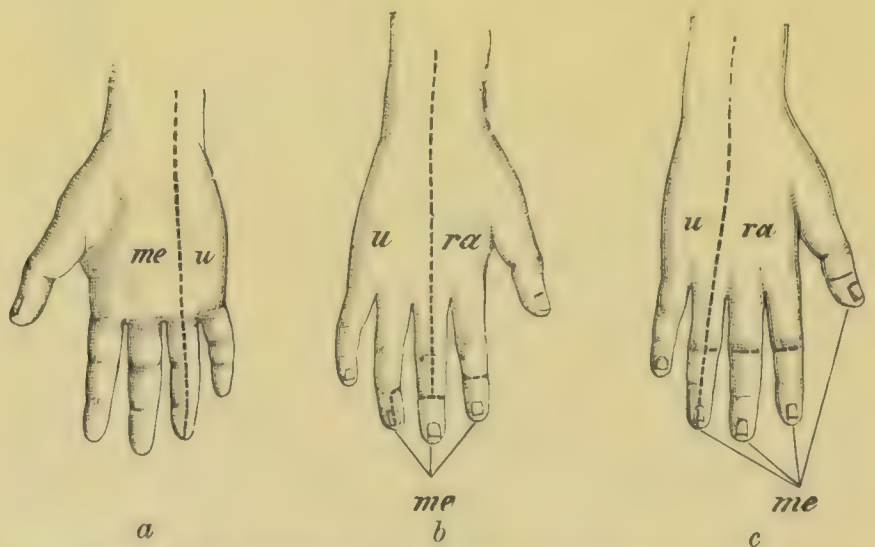


FIG. 709.—*a*, nerve supply of the skin of the palmar surface; *me*, distribution of the median nerve; *u*, ulnar nerve; *b*, nerve supply of the skin of the dorsal surface after Henle; *c*, after Hutchinson; *u*, ulnar nerve; *ra*, radial nerve; *me*, median nerve.

sensory disturbances are by no means so pronounced as the motor disturbances, because there is a very intimate mingling of the fine nerve plexuses of the median, ulnar, and radial nerves in the skin, so that sensation is still carried to the central organ through the uninjured nerve tracts. This explains why disturbances of sensation may be more or less absent in the hand after the complete division of a nerve, or why the sensation returns even when no regeneration has occurred at the

point of division. The distribution of the different nerves in the skin of the hand is represented in Fig. 709.

2. Injury of the Ulnar Nerve.—The ulnar nerve lies at first on the inner side of the axillary artery and the beginning of the brachial artery, then runs backward with the inferior profunda artery, enters the groove between the internal epicondyle and the olecranon, and descends between the two heads of the flexor carpi ulnaris muscle, and between the latter and the flexor digitorum profundus on the inner side of the ulnar artery. Somewhat above the wrist joint it divides into a dorsal and a palmar branch, and the latter is again divided into a superficial and a deep branch. The ulnar nerve, as has already been mentioned, supplies on the forearm the flexor carpi ulnaris and the ulnar side of the flexor digitorum profundus. The dorsal branch supplies, with the radial nerve, the skin of the dorsum of the hand, as shown in Fig. 709 *b* or *c*. The palmar branch divides in the hand into a superficial branch for the skin of the ulnar border of the hand (Fig. 709 *a*), and for the lumbricales muscles of the fourth and fifth fingers, and a deep branch, which, lying beneath the deep palmar arch, supplies the muscles of the hypothenar eminence, all the internal and external interossei, the adductor brevis pollicis, and the deep head of the flexor brevis pollicis.



FIG. 710.—*Main en griffe* following paralysis of the ulnar nerve.

The appearance of the hand in case of complete paralysis of the ulnar nerve is very characteristic (Fig. 710). Ulnar flexion and adduction of the hand is restricted, complete flexion of the last three fingers is difficult or impossible, movement of the little finger is almost entirely suspended, and separation and approximation of the fingers, as well as flexion of the first and extension of the second and third phalanges of all the fingers, is impossible, in consequence of paralysis of the interossei muscles. The thumb can not be adducted. The hand assumes in time the characteristic *main en griffe* as represented in Fig. 710. This is especially true of the last two fingers, but less so of the others, because their lumbricales muscles are supplied by the median nerve.

For the disturbance of sensation attending paralysis of the ulnar nerve the reader is referred to Fig. 709.

3. Injury of the Musculo-spiral Nerve.—The musculo-spiral nerve passes between the brachialis anticus and the supinator longus muscles in front of the external condyle and the head of the radius, and here divides into a large deep branch and a smaller superficial branch. The deep branch perforates the supinator brevis muscle, passes around the neck of the radius, then runs between the superficial and the deep layer of extensors, as the posterior interosseous, and ends as a small nerve on the posterior circumference of the

wrist joint. The superficial or radial branch runs downward in the bend of the elbow in front of the radius, then lies on the outer side of the radial artery and beneath the supinator longus muscle, perforates the fascia of the forearm, and finally divides, in the region of the wrist joint, into a palmar and a dorsal branch for the skin of the thenar eminence and the dorsum of the hand (see Fig. 709). The musculo-spiral nerve supplies the triceps muscle, a small part of the brachialis anticus, and all the muscles on the extensor side of the forearm.

In case of complete paralysis of the musculo-spiral nerve, the muscles that have just been named are paralyzed. The functional disturbance of the hand (Fig. 711) is more marked than

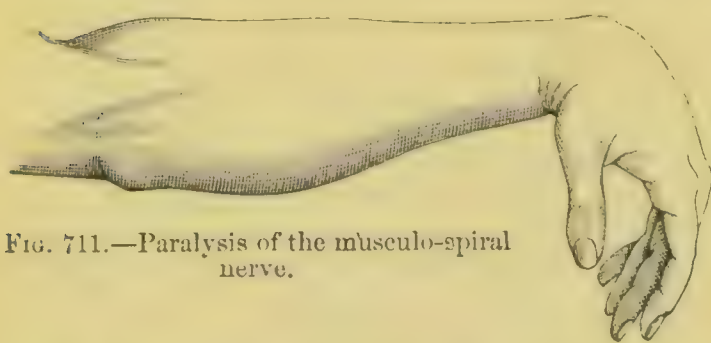


FIG. 711.—Paralysis of the musculo-spiral nerve.

in any other paralysis of the arm. The patient can not hold or grasp anything, and has no power of supination. The hand hangs in a relaxed position of flexion and is incapable of

dorsal flexion. Extension of the first phalanges is impossible. The two end phalanges only can be somewhat extended by the lumbricales and interossei muscles. The thumb can not be abducted. Supination of the forearm is impossible, and in case of paralysis of the triceps muscle the forearm can not be extended. For the disturbances of sensation the reader is referred to Fig. 709.

Substitution of mobility as well as of sensation (see above) has been observed in connection with paralysis of the nerves of the forearm in the sense that, to a certain degree, other muscles which are not paralyzed assume the function of the paralyzed muscles, so that the paralysis can be partially concealed thereby. Such substitutions occur especially in the muscles which are supplied by the median and ulnar nerves. The two nerves supplement each other to a great extent and anastomose with one another (Létiévant, the author). Küster resected the median nerve on account of a gliosarcoma, and the fingers could nevertheless be moved as before the operation. Anatomical irregularities in the course of the nerves can, to be sure, be imagined in such cases.

Treatment of Traumatic Paralyses.—In treating all cases of injuries of nerves, whether recent or of long standing, one should expose the site of injury and then proceed according to what is found. Cicatricial bands, callus masses, etc., that exert pressure are removed. In fresh cases of division of a nerve, the ends are united by fine catgut sutures inserted either directly through the substance of the nerve or only

through the nerve sheath or surrounding connective tissue. Division of a nerve of long standing should also, if possible, be remedied by suture. Even after months and years favourable results have been secured by this late neurorrhaphy. In such cases the nerve ends which are adherent to the surrounding tissue are dissected free and freshened, and then united with catgut. The same rules apply for the after-treatment of a neurorrhaphy as for that of suture of a tendon—that is, the line of suture must here also be relaxed as much as possible by giving the hand or the forearm a suitable position.

If the direct union of the ends is attended with difficulty—e. g., in case of a defect in the nerve—one should first attempt to lengthen the nerve by stretching it. One may also, as in case of defects in a tendon, bridge over the defect in the nerve by forming a pedunculated flap from one or both nerve stumps (Fig. 712). I treated a defect in the median and ulnar nerves of several months' standing in this way with complete success. The defect in the nerve may also be supplied by the ingrafting of a piece of nerve from a rabbit or a dog or by the insertion of threads of catgut or a drainage-tube of decalcified bone into which the stumps of the nerve are introduced (Gluck, Vanlair, and others). It is of prime importance in case of a defect in a nerve to prevent the stumps from being separated by a bridge of connective tissue. One must, on the contrary, strive to facilitate the passage of the newly formed nerve fibres from the proximal to the distal stump, and this is best accomplished by one of the methods just described. In case of extensive defects, Löbker suggested shortening the bones of the forearm by resecting a piece of bone from their continuity. It has furthermore been proposed, in case suture of the nerve is impossible on account of too great distance between the stumps, to unite the distal stump with a neighbouring intact nerve, as Després has done successfully (so-called nerve-

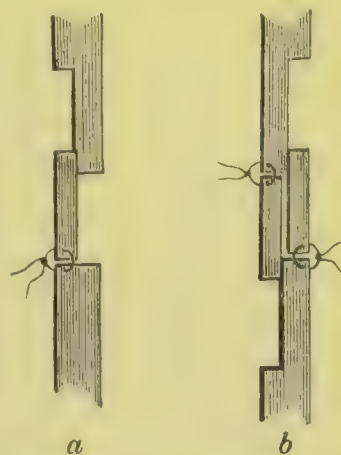


FIG. 712.—Neuroplasty for defect in a nerve: *a*, formation of a pedunculated flap from one stump of the nerve: *b*, formation of a pedunculated flap from each stump.

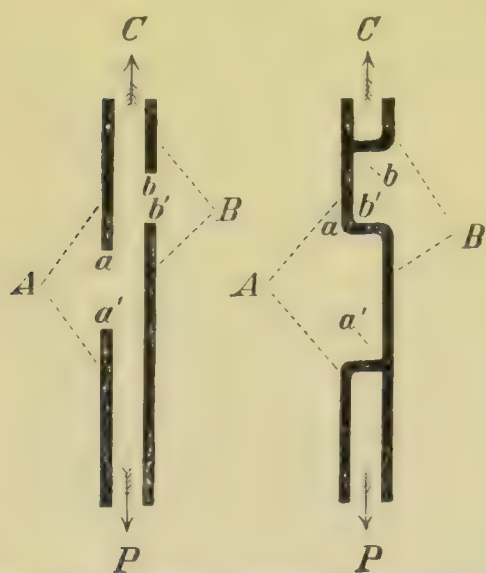


FIG. 713.—Union of two adjacent nerves for a nerve defect: *C*, central organ; *P*, periphery.

posed, in case suture of the nerve is impossible on account of too great distance between the stumps, to unite the distal stump with a neighbouring intact nerve, as Després has done successfully (so-called nerve-

grafting). Després inserted the distal end of the ruptured median nerve between the fibres of the ulnar nerve which were separated with forceps. The success obtained in this way is open to doubt. In case there are defects at different heights in two neighbouring nerves, one may also proceed according to Fig. 713. It has not yet been proved whether or not success is to be attained by this method.

The results of neurorrhaphy, primary as well as secondary, are excellent. In the after-treatment, massage and electricity are of great importance. For the results of neurorrhaphy, nerve regeneration, etc., the reader is referred to Principles of Surgery, page 473.

§ 296. **Wounds and Ligation of the Radial and Ulnar Arteries.**—Wounds of the arteries of the forearm are rather frequent, and are treated by tying both ends of the vessel in the wound.

Ligation of the Radial Artery (Fig. 714, 2).—In tying the artery in the upper third of the forearm, the skin incision is begun three finger breadths below the bend of the elbow, corresponding to the depression between the pronator teres and the supinator longus muscles. After dividing the fascia, one makes his way into the interspace between the supinator longus and the flexor carpi radialis muscles, and finds the artery accompanied by two veins. The radial nerve lies on the outer side. At the middle of the forearm the artery is found in the continuation



FIG. 714.—1, ligation of the brachial artery at the bend of the elbow; 2, ligation of the radial artery; 3, ligation of the ulnar artery.

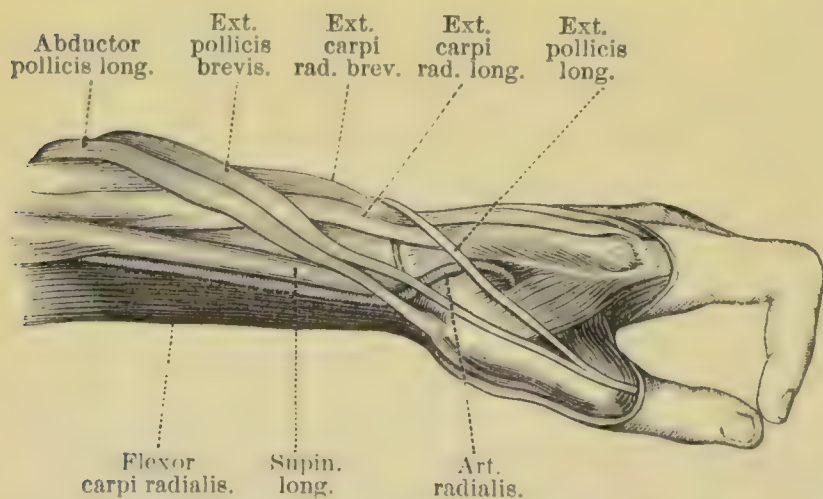


FIG. 715.—Muscles and tendons of the wrist, with the dorsal branch of the radial artery (after Henle).

of the same line, and likewise between the supinator longus and flexor carpi radialis muscles.

In tying the artery just above the wrist, an incision five centimetres in length is made on the radial side of the flexor carpi radialis muscle which

can be distinctly felt. After dividing the fascia of the forearm, the artery is found with its two veins between the flexor carpi radialis and

the supinator longus muscles. The location of the dorsal branch of the radial artery at the wrist joint before its entrance into the interosseous space between the thumb and the forefinger is represented in Fig. 715.

Ligation of the Ulnar Artery (Fig. 714, 3).—In the upper third of the forearm the artery is found, after dividing the skin and the fascia, in the interspace between the flexor carpi ulnaris and the flexor digitorum communis sublimis. The ulnar nerve lies to its inner side. The skin incision begins about three finger breadths below the bend of the elbow in a line which divides the ulnar third of the palmar surface of the supinated forearm from the middle third.

Above the wrist the artery is reached by means of a skin incision four or five centimetres long on the radial border of the tendon of the flexor carpi ulnaris above the pisiform bone, which can easily be felt. After dividing the fascia, the artery is found between the flexor carpi ulnaris and the tendon of the flexor digitorum sublimis. The ulnar nerve lies on the inner side of the artery.

Aneurisms in the Forearm occur usually after injuries. For their symptomatology and treatment the reader is referred to the more detailed description in Principles of Surgery, page 532 ff. Stromeyer and Krause observed an interesting case of arterio-venous aneurism, with circulatory disturbances involving the whole extremity, in consequence of communication between the arteries and veins (Fig. 716).

§ 297. **Fractures of the Forearm.**—1. *Fracture of both bones of the forearm* is due most commonly to direct violence, from a thrust, a blow, or from being run over, less often indirectly from a fall upon the hand. In fractures resulting from direct violence the bones are broken at the same level, while in indirect fractures that of the ulna is usually higher than that of the radius. The fracture is most frequently in the lower or middle third of the bone, less often in the upper



FIG. 716.—Arterio-venous aneurism of the left forearm and hand in a man forty-five years of age which developed gradually in his seventh year after a dog bite of the hand. Numerous sacculated aneurisms on the flexor side (A), and extensive varicose enlargement of the veins on the extensor side (B).

third. Sometimes, especially among children, incomplete or "greenstick" fractures are observed. The degree and the character of the displacement depend upon the location of the fracture, upon muscular action, and especially upon the direction in which the violence acts. The fragments are most frequently displaced toward the interosseous space, a fact which is important as regards its treatment, or laterally toward the ulnar or radial side. The bones may also be rotated about their longitudinal axis, and may present a deformity on the palmar or dorsal aspect.

The symptoms of a fracture of the forearm, especially in case of complete fracture of the radius and the ulna, are usually well marked, because abnormal mobility, crepitus, displacement of the fragments, a localized point of tenderness, and a corresponding extravasation of blood are, as a rule, easily demonstrable. Impacted fractures of the



FIG. 717.—Synostosis ("bridge callus") following fracture of the forearm, with complete loss of rotation.



FIG. 718.—Hypertrophic callus after fracture of the forearm, with limitation of rotation.



FIG. 719.—Malunion of a fracture of the radius, with limitation of rotation.

forearm are very rare. In case of displacement of the fragments, there is usually a corresponding angular bending of the forearm toward the side or toward the anterior surface. All active movement of the forearm is suspended, and the latter is correspondingly shortened. The diagnosis is easiest in fractures of the lower and middle third of the forearm, being more difficult in the rare cases of fracture of the upper third, where palpation of the bone is less easy on account of

the thickness of the overlying muscles. In case of incomplete fractures ("green-stick" fractures) there is found a slight anterior or lateral bending of the forearm. The localized point of tenderness and the extravasation of blood are also important from a diagnostic point of view.

The prognosis of a fracture of the forearm may be made less favourable, especially by incomplete reduction or faulty immobilization of the fragments. Pronation and supination of the forearm are most frequently restricted or wholly suspended by malunion of fractures, especially by a synostosis between the radius and the ulna (Fig. 717), by a hypertrophic callus (Fig. 718), by angular deformity of one or both bones—the radius, for instance, as in Fig. 719—and, finally, by cicatricial shortening or partial ossification of the interosseous ligament. These contractions or partial ossifications of the interosseous ligament occur especially in cases of union with an angular deformity, as in Fig. 719, for instance, but occasionally also when the bone is in its normal position. Pseudarthrosis occurs most commonly from the interposition of muscles and tendons between the fragments and in comminuted fractures. Gangrene of the hand has been observed in exceptional cases in consequence of rupture of the vessels. Under normal conditions bony union usually ensues in from twenty to thirty days.

In treating a fracture of both bones of the forearm, any deformity is to be overcome by traction and counter-traction, and then the forearm is put up in full supination, with the elbow flexed at right angles, so that the patient looks into the hollow of his hand. The splint should consist of a dorsal and palmar portion and reach from the upper arm to the metacarpo-phalangeal joints. The materials used are wood, pasteboard, felt, plaster of Paris, etc. (see Principles of Surgery, pages 205–208). The splint should be removed very frequently, every six or eight days at least, in order to make sure of the position, and the arm massaged gently. The splints must be broader than the arm and well padded with cotton, in order that there may be no circular constriction of the arm by which the fragments may be brought too close together. Such splints are far preferable to those of plaster of Paris, because the position of the fragment can not be so well controlled with the latter. One must guard especially against putting on the splints too tight, and the country practitioner should be particularly careful in the use of splints on the forearm. One should always pad them sufficiently with cotton, and keep the patient under observation for from six to twelve hours after their application to determine whether or not they are too tight. Much harm has been done by too tight plaster-of-Paris splints on the fore-

arm. Ischaemic paralysis of the muscles of the forearm, giving rise to *main en griffe*, and, it may be, complete loss of the function of the hand, has resulted from this cause in a number of cases. In these ischaemic paralyses we have to do with a rapid destruction of the contractile elements of the muscles, in consequence of disturbance of nutrition from the tightness of the splint (Volkmann, Leser). Incurable ischaemic paralyses of the muscles have been seen to occur even within twenty-four hours after the application of too tight plaster-of-Paris splints on the forearm. Gangrene from the same cause occurs only in exceptional cases.

2. *Fractures of the Ulna.*—For fractures of the olecranon and the coronoid process see page 577.

Fracture of the shaft of the ulna is rare. It occurs most frequently in the upper third or at the boundary between the upper and middle thirds in connection with simultaneous dislocation of the head of the radius forward, backward, or outward (Fig. 720), according to the direction in which the violence acts. Fractures of the middle and lower third are rare. Almost all the fractures are caused by direct violence. In every case of fracture of the shaft of the ulna the elbow joint should be carefully examined

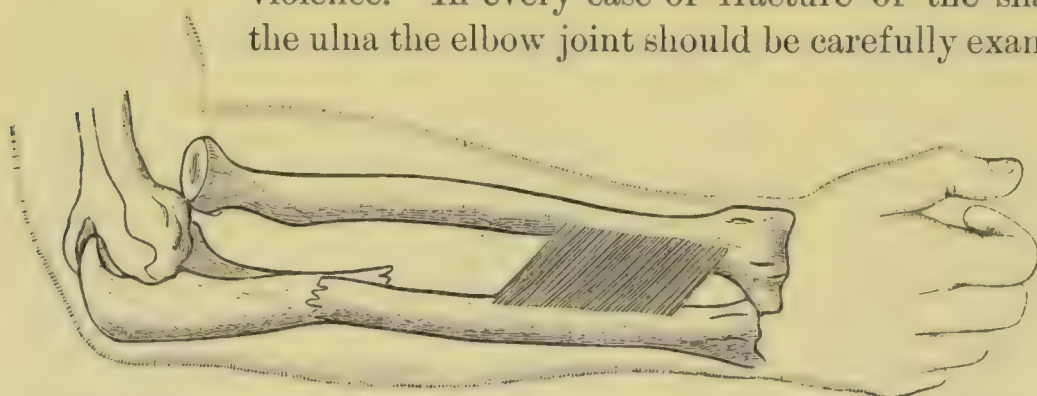


FIG. 720.—Fracture of the ulna and forward dislocation of the head of the radius.

with reference to the existence of a dislocation of the radius. Other complications that may occur are fracture of the external epicondyle and condyle of the humerus, subluxation of the styloid process of the ulna, and rupture of the musculo-spiral nerve.

The symptoms of a fracture of the ulna are well characterized and the diagnosis is usually easy, because the posterior border of the ulna can be distinctly palpated along its entire length. The site of fracture can therefore be felt easily, as a rule, especially if any extravasation of blood that may exist is removed by light massage. Abnormal mobility and crepitus are readily made out, especially on rotating the arm. The two fragments generally override and are displaced toward the interosseous space (Fig. 720). In case of simultaneous dislocation of the head of the radius, the forearm is shortened and slightly pronated.

The elbow joint is in semi-flexion, and further flexion, as well as supination of the arm, are prevented. Compound fractures are comparatively frequent, in consequence of the superficial location of the shaft of the ulna.

The prognosis is altogether favourable if the fracture receives proper treatment and no complications exist. If a marked lateral displacement is not wholly corrected, pronation and supination of the forearm may easily be restricted. Functional disturbances of the elbow joint may also arise from a dislocation of the head of the radius that is not recognised or not reduced.

The treatment of a fracture of the ulna is as follows: After reduction of any existing dislocation of the radius by extension, direct pressure upon its head and flexion of the elbow joint, as well as the correction of any displacement at the site of fracture, a plaster-of-Paris or wood splint is applied for from two to four weeks, the forearm being flexed at an acute angle and kept halfway between pronation and supination. If there is a pseudarthrosis of the ulna in consequence, for example, of a defect after a comminuted gunshot fracture, one should expose the site of the injury, freshen the fragments, and either insert into the defect pedunculated flaps of periosteum and bone from the ends of the bone, after Nussbaum, or unite the freshened fragments by suture, with simultaneous osteotomy of the radius. In case of old unreduced dislocations of the head of the radius, resection, with simultaneous osteotomy of the ulna, it may be, is to be recommended if reduction is unsuccessful.

Fracture of the styloid process of the ulna alone is very rare. It occurs occasionally from direct violence, but is more frequently caused by traction of the inferior radio-ulnar ligaments in connection with a fracture of the lower end of the radius. The fragment of bone that is broken off can usually be easily felt under the skin. The fracture, as a rule, unites by pseudarthrosis, without, however, any impairment of the function of the hand.

The treatment consists in securing the fragment of bone by means of strips of adhesive plaster, and in placing the forearm or the wrist joint upon a splint, much as in a fracture of the lower end of the radius. During the after-treatment care must be taken that the styloid process is not displaced again by pressure of the sling for the arm.

3. *Fractures of the Radius.*—Fractures of the head and neck of the radius have already been described on pages 579, 580.

Fracture of the shaft of the radius is rare. According to a tabulation by Falkson, only four out of one hundred and fifty-five fractures of the radius involved the shaft. These fractures arise sometimes

from direct and sometimes from indirect violence—e. g., in consequence of a fall upon the hand, or from forcible pronation, in wringing clothes, for instance.

The symptoms are the least pronounced when the fracture is in the upper third. A displacement of the fragments may be entirely absent. The displacement depends essentially upon the direction in which the violence acts and upon the location of the fracture—that is, upon whether the bone is fractured below or above the insertion of the pronator teres muscle. In the former case there is usually a distinct angular deformity, the angle opening toward the back or the front. If the fracture is above the insertion of the pronator teres muscle, the upper fragment is supinated and flexed by the biceps and the supinator brevis muscles, while the lower fragment is pronated by the pronator teres and the pronator quadratus, and drawn in the direction of the ulna. Crepitus and abnormal mobility are most easily made out by placing the hand upon the site of fracture and rotating the forearm, whereupon the head of the radius does not move unless there is an impacted fracture. Active pronation and supination of the hand are impossible and passive movements very painful. If the lower fragment is displaced, the axis of the wrist joint is correspondingly altered and the head of the ulna is abnormally prominent (Bardeleben). The farther down the fracture is located near the wrist, the more distinctly visible is the changed axis of the latter (see also Fracture of the Lower End of the Radius).

The treatment of a fracture of the shaft of the radius consists in the application of a splint of wood or plaster of Paris while the forearm is in supination and flexion. The elbow and the wrist should be included in the splint. Bony union usually ensues in three or four weeks. The same precautions are to be observed in treating fractures of the shaft of the radius as in dealing with those of both bones of the forearm, in order that pronation and supination of the hand may not be disturbed (see page 611). In pseudarthrosis, due, for example, to a defect in the bone, the formation of pedunculated flaps of periosteum and bone from one or both fragments, after Nussbaum, is to be recommended, or suture of the freshened fragments, with corresponding osteotomy of the ulna.

Fracture of the lower end of the radius, about one or two centimetres above the articular surface, is the most common of all fractures.* The line of fracture usually runs transversely from one side

* This typical fracture is known in this country as Colles's fracture, and hence the latter designation will be used in its description.—TRANS.

to the other and somewhat obliquely from the anterior to the posterior aspect. This fracture arises very rarely from direct but almost always from indirect violence, especially from dorsal flexion of the hand caused by a fall upon its palmar surface, and sometimes also from palmar flexion of the hand attending a fall upon its dorsum. In the former case the hand undergoes sharp dorsal flexion and the lower end of

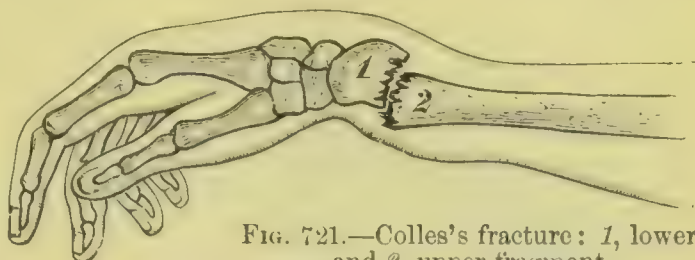


FIG. 721.—Colles's fracture: 1, lower, and 2, upper fragment.

the radius is really torn off by the tense ligamentum carpi volare profundum. The hand and the lower fragment are displaced together toward the dorsum, while the upper fragment is displaced anteriorly (Fig. 721). This is the typical position of the fragments in a complete fracture. Much less frequently the reverse is true—i. e., the fracture arises from violent palmar flexion of the hand attending a fall upon its

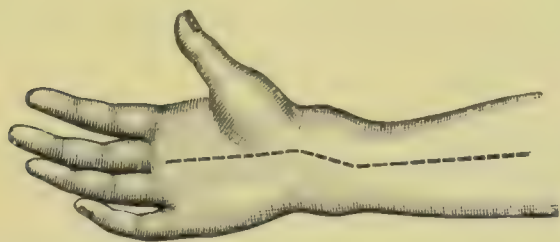


FIG. 722.—Deviation of the hand toward the radial side in Colles's fracture.

dorsum. Here also the lower end of the radius is torn off by a tense ligament—viz., the ligamentum carpi dorsale profundum. In the latter case the position of the fragments is usually the reverse of that represented in Fig. 721—that is, the hand and the lower fragment are displaced anteriorly and the upper fragment

posteriorly. In addition to the action of the ligaments, the forcible contact of the anterior or posterior edge of the radius against the first row of carpal bones is an important factor in the causation of these fractures. The fragments are sometimes impacted, or the fracture is an incomplete one. Comminuted fractures are, generally speaking, rare. Fissures are sometimes found which extend into the joint.

The symptoms of Colles's fracture are very characteristic, so that the diagnosis can usually be made at first glance in recent cases. In consequence of the usual displacement, shown in Fig. 721, one sees upon the dorsum of the hand, in the region of the wrist joint or just above it, a prominence which corresponds to the lower fragment, and farther up a distinct depression; while on the flexor side of the forearm, likewise above the wrist joint, there is a fulness caused by the anterior displacement of the upper fragment. The French very properly compare this characteristic deformity with a table fork (*dislocation à la fourchette*). The hand is, moreover, slightly adducted (Fig. 721),

and the lower end of the ulna is abnormally prominent. This adduction of the hand is probably conditioned upon the fact that the upper end of the lower fragment is drawn toward the ulna by the pronator quadratus muscle, while the lower end of the same, with the hand, deviates in the opposite—that is, in a radial direction. The hand is, moreover, perfectly powerless and incapable of performing its function. It can neither be pronated nor supinated. Crepitus and abnormal mobility can easily be made out, as a rule, by grasping the site of fracture with one hand and moving with the other the hand of the patient in a dorsal, volar, or lateral direction. Abnormal mobility and crepitus are absent in impacted fractures. The localized pain above the styloid process of the radius and the extravasation of blood are of importance here. Sprains of the wrist and Colles's fractures are frequently mistaken for one another. In case of a sprain the joint itself is the seat of the pain, while in case of fracture the latter is one or two centimetres above the styloid process in the radius itself. If, in case of a large effusion of blood, one is in doubt whether he has to do with a fracture or a sprain, the case should be treated at first as a fracture and a splint applied.

For the differential diagnosis between a Colles fracture and a dislocation of the wrist, see § 300, page 623 ff.

The prognosis of Colles's fracture under proper treatment is altogether favourable in simple transverse fractures without fissures running into the joint. Bony union almost always ensues in three or four weeks, though the time may be lengthened to five or six weeks, rarely longer, in elderly and feeble patients. Permanent impairment of the function of the wrist is occasioned especially by malunion of a fracture, comminuted fractures, and by direct injuries of the radio-carpal and the radio ulnar joints. Arthritis deformans is especially to be feared among old people. Synostosis between the radius and the ulna sometimes attends coexistent fracture of the lower end of the ulna. Disturbances of growth with radial flexion of the hand are occasionally observed among young persons, in consequence of separation of the epiphysis. Among other complications by which the prognosis may be made less favourable, there are to be mentioned dislocation of the ulna at the inferior radio-ulnar joint, crushing off of the styloid process of the ulna and of small fragments from the lower edge of the latter, extensive extravasations of blood in the tendon sheaths and in the palmar synovial sac, injuries of the arteries and nerves, etc. Gangrene of the hand has been observed in rare cases after rupture of the radial and ulnar arteries. One should guard, above all, against putting on too tight a splint, by which the ischaemic paralysis of the muscles of the forearm, already mentioned on page 612, with the *main en griffe*, it may be, are only too easily occasioned. The splint should furthermore not be kept on too long, and massage and exercise of the joints should be begun as early as possible—e. g., after the removal of the first splint or in the second week. The stiffness of the wrist joint and the fingers, which was formerly so common, is best avoided in this way.

The treatment of Colles's fracture is to be carried out with great care, in order that the above-mentioned evils, especially malunion of the fracture and disturbances of the function of the wrist joint, may be avoided. The displacement is overcome by traction on the hand in the line of the forearm, which is flexed at right angles at the elbow, and by counter-extension on the upper arm. Traction in a straight line should be combined with ulnar flexion and then palmar flexion of the hand, in order to correct the radial deviation of the latter. In this position, which is directly the opposite of the existing deformity, the forearm is immobilized by a splint midway between pronation and supination. It is sometimes a good plan during the after-treatment to alternate between pronation and supination of the hand. If there is a simultaneous fracture of the lower end of the ulna, complete supination of the forearm with ulnar abduction of the hand is sometimes advisable.

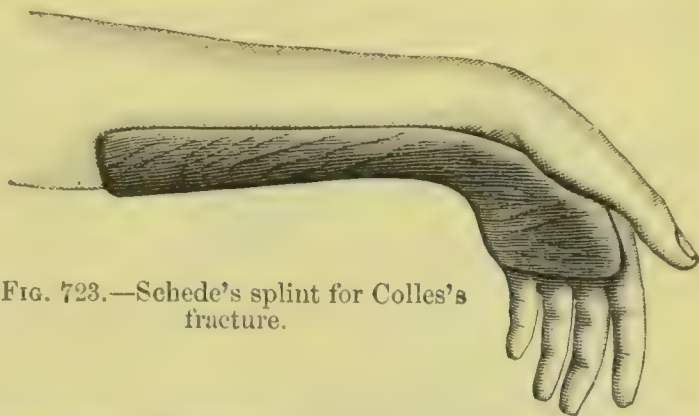


FIG. 723.—Schede's splint for Colles's fracture.

Ordinary wooden splints are decidedly to be preferred to those of plaster of Paris. They are more easily changed, and permit the forearm to lie in a more advantageous position. Schede's anterior splint, which keeps the hand flexed and abducted, is strongly to be recommended (Fig. 723). I also like Carr's splint (Fig.

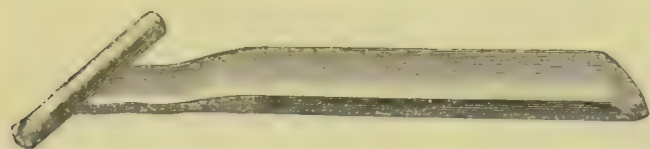


FIG. 724.—Carr's splint for Colles's fracture.

724), upon which the forearm is so placed that the patient grasps with the hand the transverse piece in front. In order to secure palmar flexion of the hand, a wad of cotton is inserted above the wrist joint, by means of which the upper fragment is pressed toward the dorsum. Bardenheuer uses a splint which produces extension by elastic traction. It consists of a splint for the hand and one for the forearm, which are connected by a hinge joint, so that the splint for the hand can be placed in various positions. Among the posterior splints that are in use, Nélaton's pistol splint (Fig. 725) and Roser's splint (Fig. 726) are especially to be recommended. Braatz used a spiral splint of plaster of Paris and hemp. It begins about three finger breadths below the olecranon, embraces the ulna, covers the palmar surface of the forearm, and passes over the site of the fracture to the dorsum of the hand, where it ends at the metacarpo-phalangeal joints. During the application of

this splint or until it has become hard, the hand must be held in palmar flexion and ulnar abduction, as was described above. All splints must be well padded with cotton and secured at first with flannel or mull bandages and then with gauze bandages. One may use as an outer covering bandages of water glass or



FIG. 725.—Nélaton's "pistol splint" for Colles's fracture.

plaster of Paris. Splints are to be changed frequently—e. g., every six or eight days—and at these times the wrist and fingers are massaged and exercised. If the first splint is put on while there is much swelling, it often requires to be changed

even sooner. All splints reach on the hand as far as the metacarpophalangeal joints, so that the fingers can be moved with perfect freedom. Splints are discarded after three or four weeks, often even earlier, and use is made of baths, massage, etc.

If plaster of Paris is chosen as a splint (see Principles of Surgery, page 216 ff.), it should be well padded with wadding and likewise renewed in about a week, in order that the fracture may be inspected. The plaster-of-Paris bandages may also be applied with the hand in a position of palmar flexion and ulnar abduction. The upper fragment can be pressed into position by means of a pad of cotton laid upon the site of fracture on the flexor side of the forearm.

Every splint on the forearm must be carefully watched, to see that it does not exert pressure and is not too tight. Every physician should make it a rule, when he has applied a splint in the morning, to look at it the same day, so as to determine whether or not it is serving its purpose properly.

Compound fractures are treated under antiseptic precautions and in accordance with general rules (see Principles of Surgery, pages 597 and 732). The reader is likewise referred for the treatment of pseudarthrosis to Principles of Surgery, page 603.

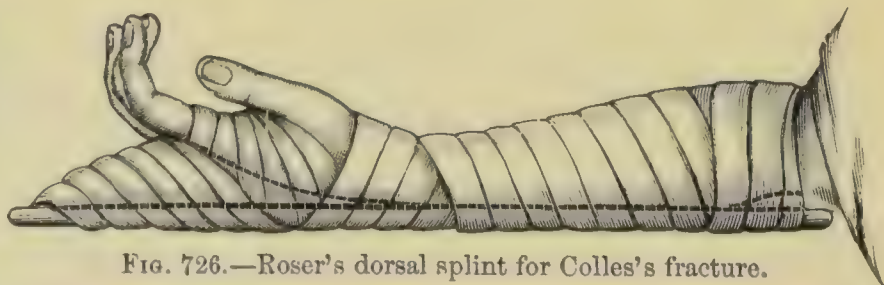


FIG. 726.—Roser's dorsal splint for Colles's fracture.

In case of malunion of a fracture, partial or complete refracture of the bone is sometimes advisable and the application of a splint in a proper position. Refracture of the bone is unfortunately often impossible, because the lower fragment is too small. In such cases the function of the hand is

often very materially improved by massage, by exercise of the wrist, and by electricity. Osteotomy, or the chiselling away of any mass of callus that causes disturbance, may be indicated. In case of synostosis of the lower end of the radius and the ulna, in connection with simultaneous fracture of the ulna, resection of the lower end of the latter is to be recommended (Lesser, Lauenstein).

§ 298. **Anatomy of the Wrist.**—Before passing to injuries of the wrist, it may be well to review the anatomy of the different articulations between the bones of the forearm, the carpal bones, and the bases of the metacarpals.

1. The inferior radio-ulnar joint (Fig. 727, 2) lies between the lower extremities of the radius and the ulna and forms a completely independent articulation. It is separated from the radio-carpal joint, the wrist joint proper, by an interarticular cartilage. This interarticular cartilage is attached to the styloid process of the ulna and to the outer edge of the radius by two fibrous bands. Near the outer border of the interarticular cartilage there is sometimes found, according to Henle, an oval opening—that is, there is in such a case a communication with the radio-carpal joint. The rotatory movements of the radius take place in this inferior radio-ulnar joint in conjunction with the superior radio-ulnar articulation. The hand follows these rotatory movements of the radius only passively. Further rotation in the inferior radio-ulnar joint

is prevented by the capsule, which is stout and passes from the edge of the interarticular cartilage without interruption into the capsule of the radio-carpal joint.

2. The radio-carpal joint (Fig. 727, 1) is formed above by the articular surface of the radius and the interarticular cartilage, and its ligament and below by the upper surfaces of the first row of carpal bones (scaphoid, semilunar, and cuneiform bones), which are united to one another by the interosseous ligaments.

The scaphoid and semilunar bones articulate with the end of the radius, while the inner border of the semilunar bone articulates with the interarticular cartilage. The cuneiform bone articulates with the lower surface of the

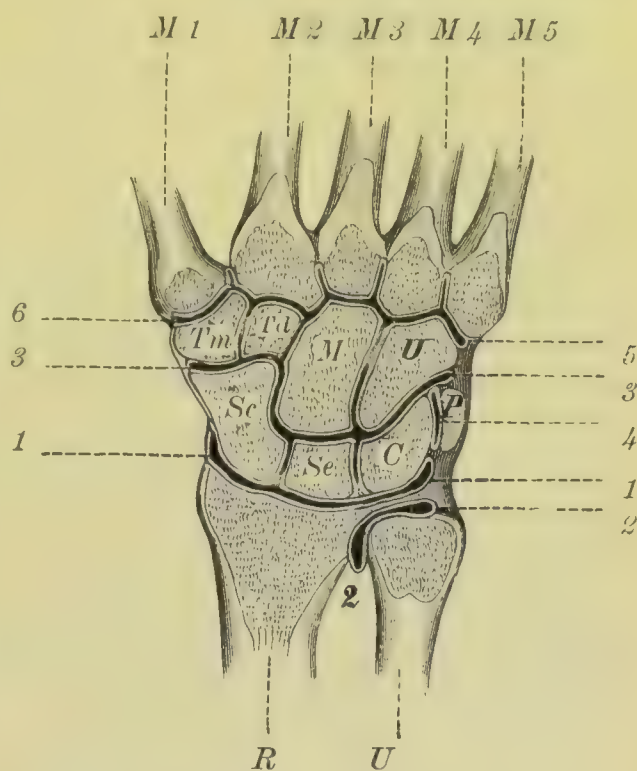


FIG. 727.—Frontal section of the right wrist showing the different articulations: *R*, radius; *U*, ulna; *M1* to *M5*, metacarpal bones; *Sc*, scaphoid; *Se*, semilunar; *C*, cuneiform; *P*, pisiform; *Tm*, trapezium; *Td*, trapezoid; *M*, os magnum; *U*, unciform; 1, radio-carpal joint; 2, inferior radio-ulnar joint; 3, mid-carpal joint; 4, joint between the pisiform and cuneiform; 5, carpo-metacarpal joint; 6, independent joint between the trapezium and the first metacarpal.

interarticular cartilage. A communication between the radio-carpal joint and the medio-carpal joint may arise from the absence of the interosseous ligaments connecting the articular surfaces of the scaphoid, the semilunar, and the cuneiform bones. A communication between the radio-carpal articulation and that of the pisiform bone is more common.

3. The mid-carpal joint. The real joint cavity of the carpus lies between the two rows of carpal bones (Fig. 727, 3), which are capable of free movements upon one another. The mobility between the first and the second row of carpal bones is especially great among weavers, the head of the os magnum and the unciform bone often projecting considerably when the wrist is sharply flexed. The single bones lying side by side have, to be sure, their cartilaginous articular surfaces turned toward one another, but still they are so firmly joined together by ligaments that movements upon one another are scarcely possible. The bones of the second row, the trapezium, the trapezoid, the os magnum, and the unciform bone are especially firmly joined together. The clefts between the bones of each row are in open communication with the mid-carpal joint. These clefts between the carpal bones are closed by ligaments, however, in front and behind toward the radio-carpal and the carpo-metacarpal joints. A communication between the mid-carpal joint and the carpo-metacarpal joint is regularly present through an open cleft between the trapezoid and the os magnum (Fig. 727), and there is an exceptional communication with the radio-carpal joint through an open cleft between the carpal bones of the first row. The form of the articular surface of the mid-carpal joint is very complicated, consisting of fragments of rotation surfaces (Henle). The capsule of the mid-carpal joint takes its origin from the borders of the carpal bones which are covered with cartilage. It forms a transverse fold on the palmar side in flexion and on the dorsum in extension.

4. The articulation of the pisiform bone (Fig. 727, 4). The pisiform bone articulates with the cuneiform by means of a very flat ball-and-socket joint.

5. The carpo-metacarpal articulation (Fig. 727, 5) between the second row of carpal bones and the metacarpal bones presents a common joint, in which but slight movements of the hand about a transverse axis—that is, flexion and extension—are possible. The carpo-metacarpal joint is not infrequently completely divided into halves by a synovial fold, which extends from the interosseous ligament between the os magnum and the unciform bone to one of the metacarpal interosseous ligaments (Henle). The regular communication between the carpo-metacarpal joint and the mid-carpal joint has been already mentioned. The dense capsule of the carpo-metacarpal joint passes from the bases of the metacarpal bones to the edges of the cartilaginous surfaces of the carpal bones.

6. The articulation between the trapezium and the metacarpal bone of the thumb is a completely independent joint, which allows free movements between the metacarpal bone of the thumb and the trapezium.

Among the accessory and strengthening ligaments the following are especially important:

The *ligamentum carpi commune*—that is, the tendinous portion of the fascia of the arm in the vicinity of the wrist joint with mainly transverse fibres. On the dorsum, the *ligamentum carpi dorsale profundum* passes

from the bones of the forearm to the first row of carpal bones, and there are numerous short dorsal ligaments between the single carpal bones (intercarpal, carpo-metacarpal, and intermetacarpal ligaments). Of the ligaments on the palmar side the following are important: 1. The ligamentum carpi volare proprium, which bridges the cavity formed by the carpal bones. 2. The ligamentum carpi volare profundum, which consists of three parts and completely covers the palmar side of the radio-carpal joint and the mid-carpal joint. We saw on page 615 that Colles's fracture of the lower end of the radius arises in part from the traction of this ligament, because it becomes continuous with the periosteum of the radius. The numerous other ligaments in the region of the carpal bones are without practical importance.

As regards the function of the different joints at the wrist, the following brief statement may be made: The normal movements of the hand consist of (1) pronation and supination; (2) flexion and extension (palmar and dorsal flexion); (3) adduction and abduction (ulnar and radial flexion); (4) flattening and arching of the hand. Pronation and supination take place in the inferior radio-ulnar joint, flexion, extension, and radial and ulnar flexion in the radio-carpal and the mid-carpal joints, and flattening and arching of the hand in the carpo-metacarpal joint, and particularly in the carpal joint of the thumb. There is also possible a dorsal and palmar flexion of the hand in the carpo-metacarpal joint which is greatest at the borders of the hand. The most immovable part of the wrist joint is the second row of carpal bones. The different movements in the joints are checked partly by contact of the bones and partly by the capsule and accessory ligaments.

§ 299. **Injuries of the Wrist.**—We mention first among injuries of the wrist the contusions arising from the action of direct violence and the sprains occurring especially from forcible rotation, flexion and extension, or adduction and abduction. Sprains of the wrist joint proper, the radio-carpal joint, are especially frequent, arising, for example, from violent dorsal flexion attending a fall upon the palm of the hand, in which, as we saw, the lower end of the radius is so often torn away by the ligamentum carpi volare profundum. In sprains there is a momentary partial separation of the articular surfaces, and complete dislocations may result from the action of greater violence. Corresponding stretching or rupture of the tense ligaments is observed in all these violent movements of the hand, including the short ligaments between the carpal bones, as well as rupture of the capsule and the interarticular cartilage of the inferior radio-ulnar joint and avulsion of portions of bone from the radius, the ulna, and the carpus, and finally stretching, laceration, or rupture of the muscles or tendons.

The symptoms of a contusion and sprain of the wrist are similar to those of Colles's fracture, and confusion of the two is therefore not infrequent. The intra-articular and periarticular effusion of blood, varying in amount, is characteristic of a contusion and sprain. The joint whose active function is disturbed is painful, while the bone, as

opposed to what is true in case of fracture, is not tender, and presents nothing abnormal.

The course is usually favourable in cases that are free from complications. There result only in exceptional cases, especially when the treatment is unsuitable, chronic inflammation or stiffness of the joint, or, on the other hand, a loose joint with subluxation, also chronic inflammation of the tendon sheaths (tenosynovitis), etc.

The treatment of uncomplicated contusions and sprains of the wrists consists in the prompt use of massage (see Principles of Surgery, page 505), systematic movements, baths, and the inunction of remedies containing alcohol. Antiphlogistics (ice) are usually necessary only during the first hours or days. The immobilization of the extremity for some days—e. g., upon a Carr splint (see Fig. 724, page 617)—is only to be recommended in severe cases with marked extravasation of blood and rupture of the soft parts. Here also massage, passive movements, baths, and the inunction of liniments are employed later. Careful attention is to be paid to any complications (fractures, rupture of the tendons, etc.). Massage is to be continued until the function of the joint is completely restored.

Wounds of the wrist joints (radio-carpal, inferior radio-ulnar, and mid-carpal) are partly punctured and partly incised or contused wounds, and may be associated with dislocations or fractures. Every penetrating wound of a joint, however small it may be, is to be looked upon as a serious injury, because the function of the hand or even the life of the patient may be endangered thereby. The surest indication that an injury to a joint has occurred is the escape of synovial fluid.

In other cases, where the joint is freely opened, one sees at once the articular cartilage lying bare. If the outer wound has already closed, the injury of the joint is a matter of doubt, and subsequent inflammation of the radio-carpal, the inferior radio-ulnar, or the mid-carpal joint first proves that we have had to deal with an injury to a joint. One should be warned against too much probing. It is better to omit it altogether.

The course of a penetrating wound of a joint is variable. If no infection of the wound has taken place, and the latter remains aseptic, healing follows without inflammation and without functional disturbance of the joint. In other cases acute suppurative inflammation of the joint ensues, with corresponding functional disturbances of the hand, or an acute septic process which may require amputation of the forearm in order to preserve the life of the patient (see Inflammation of the Wrist Joint). Gunshot wounds of the wrist joint, with comminution of the bones, are the most unfavourable injuries.

The treatment of wounds of the wrist joint conforms to general rules (see Principles of Surgery, pages 726 and 732, Gunshot Wounds). It consists, above all, in disinfection of the wound and its vicinity, and in immobilization of the joint, with or without drainage and elevation, depending on the nature of the injury (see Fig. 730, page 628). If suppurative inflammation of the joint ensues, or if it already exists, the joint is to be freely opened, disinfected, and drained, and usually resection of the joint (partial or complete, according to the extent of the suppuration) becomes necessary. In case sepsis and pyæmia are threatened, the removal of the focus of infection by amputation may be indicated.

§ 300. **Dislocations of the Radio-carpal Joint.**—Complete traumatic dislocations of the wrist joint proper are very rare, because its surfaces are so firmly joined together, especially by its ligaments, which are more likely to tear off the lower end of the radius than allow a dislocation. I was able to find in the literature of the subject but twenty-four cases, thirteen of which were backward and eleven forward. Ten were complicated by fracture—e. g., of the radius, the ulna, or both bones at once, of the styloid process of the radius and the ulna, of the articular surface of the radius or of the carpal bones. Compound dislocations of the wrist joint are caused usually by the action of great violence.

1. **Dislocations Backward** (Fig. 728).—This dislocation, of which I was able to find thirteen cases in literature, results usually from a fall upon the palm of the hand when the latter is abducted (Schüller), from violent rotation, and occasionally also from violent palmar flexion. It is usually associated with very extensive laceration of the soft parts.

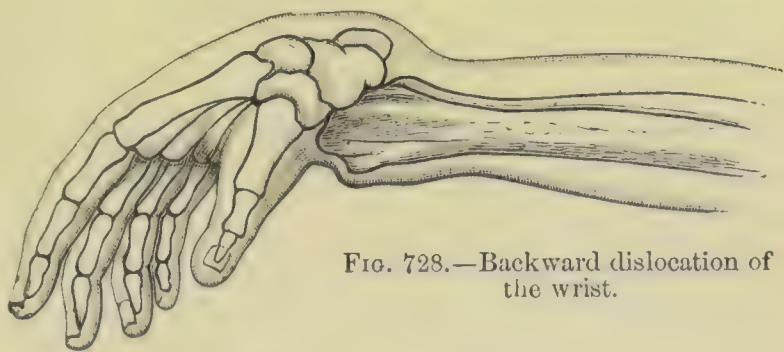


FIG. 728.—Backward dislocation of the wrist.

As regards symptoms, the deformity bears a close resemblance to that of Colles's fracture (Fig. 721). There is a prominence to be seen on the dorsum of the hand, caused by the projection of the carpal bones. The articular surfaces of the radius and ulna project on the anterior aspect, the fingers of the hand, which is in palmar flexion, are slightly bent, active movements of the wrist joint are impossible, and passive mobility is restricted. The deformity can only be overcome by special movements of reduction. The relation of the styloid process of the radius and the ulna is also of impor-

tance as regards differential diagnosis between dislocation and fracture. In dislocation these processes remain in a normal position with reference to each other, whereas their position with reference to the carpus is changed and they are felt in the palm. In Colles's fracture the styloid process of the radius is displaced with the lower fragment backward (see Fig. 721, page 615). Measurement of the radius is also important. If the radius is not shortened, but the length of the forearm from the tip of the olecranon to that of the middle finger is, the deformity at the wrist is conditioned upon dislocation.

The reduction of a dorsal dislocation of the radio-carpal joint is best accomplished by extension and direct pressure upon the projecting carpus. The hand is then immobilized for a few days upon a splint and treated as soon as possible by massage and by passive movements, which are to be begun cautiously.

2. Dislocations Forward (Fig. 729).—This dislocation is more rare than the dorsal, and yet I was able to find eleven cases in literature.

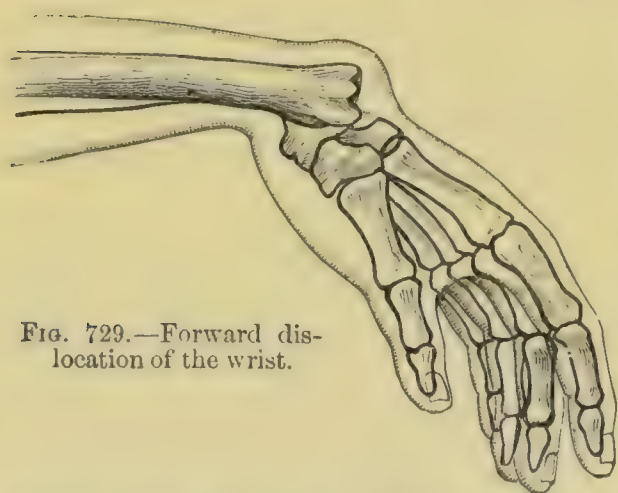


FIG. 729.—Forward dislocation of the wrist.

Hecht has recently found six more cases. It arises usually from palmar flexion attending a fall upon the dorsum of the hand, less often from dorsal flexion—that is, we have here the reverse of what is true of dislocation backward. It is also caused by violent rotation. B. Cooper had a case of special interest. He observed in a boy of thirteen, who fell from a

horse upon the palms of both hands, a forward dislocation of the radio-carpal joint on one hand and a backward dislocation of the same on the other hand.

The symptoms are the reverse of those attending dislocation backward. The lower ends of the radius and the ulna project upon the dorsum of the hand, and are the more distinctly to be felt the less swelling there is. For the differential diagnosis between fracture and dislocation the same points apply that were given on page 623.

The reduction of a dislocation forward is accomplished by extension and direct pressure upon the carpus. The after-treatment is the same as that of dislocation backward.

Compound dislocations of the radio-carpal joint are treated by aseptic methods and in accordance with general rules. The earlier they are brought under antiseptic treatment the more likely are infection

and the development of a suppurative inflammation of the joint to be prevented. Drainage of the wrist joint is not usually sufficient. It is better to make as restricted partial resections as possible, and then to employ permanent extension of the wrist (see Principles of Surgery, page 228, Fig. 213).

§ 301. **Dislocations of the Lower Radio-ulnar Joint.**—Incomplete dislocations of the lower end of the ulna from the interarticular cartilage are the most frequent. These are observed especially among little children when they are seized by the hand and lifted up (Goyaud, the author). The hand is in such cases pronated; further pronation and supination of the hand or the forearm are impossible. The joint is very painful, and the elbow joint, at which one often supposes the injury to be, is normal. The reduction of incomplete dislocation is easily accomplished by traction and rotation of the pronated hand into supination. After-treatment is unnecessary.

Complete dislocations of the lower radio-ulnar joint are, as I have shown, more frequent than was formerly supposed. They arise especially from violent pronation or supination—e. g., in wringing clothes. The ulna is dislocated either forward, backward, or inward. Of forty-eight cases of complete traumatic dislocations which I collected from the literature of the subject, sixteen (twelve simple and four compound) were dislocations forward, eighteen (ten simple and eight compound) backward, and nine inward. In five cases the direction of the dislocation was not given. Of the forty-eight dislocations, only twenty-three were uncomplicated. The others were associated with fracture of the radius or perforation of the skin.

1. Dislocation of the lower end of the ulna forward arises usually from violent supination or from the action of direct force upon the lower end of the ulna from the extensor side of the forearm. It is sometimes combined with fracture of the lower end of the radius and may be complete or incomplete. In case of coexistent fracture of the radius the diagnosis may be rendered difficult by displacement of the lower fragment of the latter.

2. Dislocation of the lower end of the ulna backward usually arises from violent pronation, from a fall upon the pronated hand, or from the action of direct force upon the ulna from the flexor surface of the forearm. According to my tabulation, eleven cases out of eighteen were without fracture of the lower end of the radius.

3. Dislocation of the lower end of the ulna inward arises from violent pronation of the forearm. I find in the literature of the subject only one case of simple dislocation with no complications—that of Rognetta. It is usually combined with fracture or with perforation of

the skin. The great rarity of simple dislocation, free from all complications, is explained by the circumstance that the lower end of the ulna easily glides off from the inner side of the carpus, and therefore passes over, as a rule, into a dislocation forward or backward in consequence of the elastically stretched soft parts and the contraction of the pronator quadratus muscle.

Congenital and pathological luxations and subluxations of the lower radio-ulnar joint have sometimes been observed. Anomalies in the position of the lower end of the ulna occur especially after severe sprains of the wrist and after malunion of fractures of the radius.

The reduction of complete dislocations of the lower radio-ulnar joint is best effected by direct pressure upon the dislocated end of the ulna and abduction of the hand. In dislocations forward, pronation of the hand, and in dislocations backward, supination of the hand are also serviceable. There is sometimes difficulty in retaining the bone in place permanently, especially when there is a coexistent fracture of the radius. In case of compound dislocations the lower end of the ulna has repeatedly been resected with favourable results. The resection of both bones of the forearm may become necessary—e. g., when there is a coexistent compound fracture. Even in severe cases no functional disturbance whatever of the joint has resulted, while in other cases the use of the hand has been very seriously impaired.

§ 302. **Dislocations of the Carpal Bones.**—These dislocations are extremely rare. I have found in the literature of the subject two cases of dislocation of the mid-carpal joint, those of Maisonneuve and Malgaigne. Maisonneuve's case was one of backward dislocation of this joint. The symptoms are similar to those of dislocation of the radio-carpal joint, with the difference that the position of the lower ends of the ulna and the radius with reference to the first row of carpal bones is not changed. Mid-carpal dislocations are caused usually by the action of great violence, so that severe associated injuries usually exist.

The reduction of a dislocation of the mid-carpal joint is accomplished in the same way as the similar dislocations of the radio-carpal joint—that is, by extension and direct pressure.

Dislocations of the single carpal bones are very rare, and usually arise from direct violence. The isolated dislocation of the os magnum, which is the most movable, and whose head allows most of the movement between the first and second row of carpal bones, is the commonest. The head of the os magnum moves about a transverse axis in flexion and extension of the hand, and about a sagittal axis in adduction and abduction. This bone forms the keystone of the carpal arch, like the astragalus in the foot. The dislocation of the head of the os

magnum seems, according to the observations already made, to be always backward and incomplete, while a dislocation forward is prevented by its firm ligamentous connection with the neighbouring bones (the unciform, the trapezoid, and the third metacarpal), as well as by the ligamentum carpi volare. Dislocation of the os magnum or its head backward arises usually from direct violence, also from violent palmar flexion, when the radio-carpal joint is fixed, and from a fall upon the clinched fist, when the shock falls chiefly upon the metacarpal bone of the middle finger, which is the most prominent.

Of other isolated dislocations of the carpal bones there have been observed those of the scaphoid, the trapezium (especially backward); also of the semiulnar (especially forward), of the pisiform, etc. Several carpal bones are sometimes torn away from their connection with the neighbouring bones by the action of unusual violence.

The reduction of the dislocations of single carpal bones is most successfully effected by direct pressure and by extension on the hand, with or without palmar or dorsal flexion, according as the dislocation of the bone is backward or forward. If reduction is unsuccessful, excision of the dislocated bone is to be recommended, as well as in compound dislocations.

Fractures of the carpal bones usually arise only from the action of great violence. They are mostly compound, comminuted fractures—e. g., from being run over, from a fall, or a blow with a heavy hammer, etc. The displacement of the fragments is usually slight, because they are held firmly by the stout ligaments. The most important symptoms of a fracture of the carpal bones are pain, swelling, and crepitus. The fractures are sometimes combined with dislocation. In the most severe cases the carpal bones are crushed to a pulp.

The treatment of simple fractures of the carpal bones consists in the application of a splint and, it may be, elevation of the hand and the use of ice for the first few days. Compound fractures are treated with antiseptic precautions and according to general rules (see Principles of Surgery, page 597, also page 600 [Fractures of Joints], and page 732 [Gunshot Fractures]).

§ 303. **Inflammatory Processes and other Diseases of the Forearm and the Wrist.**—Acute inflammations of the forearm are very frequent, especially after wounds of the hand and the fingers, often of the most trivial character. Lymphangitis of the forearm arises in this way with its characteristic red streaks in the skin reaching to the bend of the elbow and on to the axilla. Erysipelas also occurs here, as well as the superficial and deep forms of cellulitis which involve the tendon sheaths and intermuscular spaces. Septic, progressive cellulitis not infre-

quently results from slight punctured wounds of the fingers, which spreads with great rapidity, so that even after a few days amputation of the arm or disarticulation at the shoulder becomes necessary in order to preserve the life of the patient. Septic cellulitis—e. g., after a wound of a finger—usually extends slowly until it reaches the carpus, but when it has once reached the forearm the extension of the suppuration in the loose intermuscular connective tissue and in and about the tendon sheaths is generally very rapid, as well as along the lymphatics and veins (lymphangitis, perilymphangitis, phlebitis, periphlebitis). The tendons of the forearm, especially on the flexor side, are more or less destroyed by the suppuration, so that one can often draw them

out in the form of long cords of dead tissue permeated with pus. Large abscesses may develop in the epitrochlear and axillary glands.

In treating acute inflammatory processes of the forearm one should, above all, by way of prophylaxis, deal with every wound of the forearm, the hand, or the fingers under strict antiseptic precautions. Elevation of the arm—e. g., on a Volkmann's

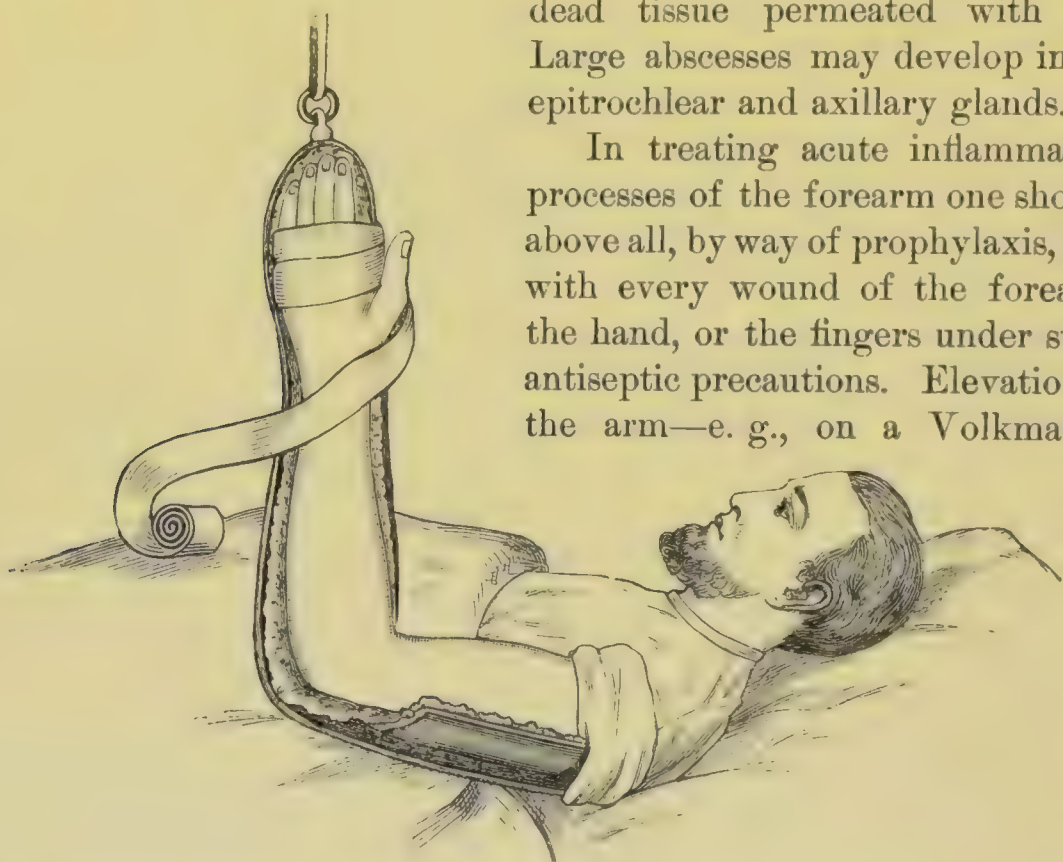


FIG. 730.—Vertical suspension of the forearm by means of Volkmann's suspension splint for acute inflammations of the hand and forearm.

suspension splint (Fig. 730)—does excellent service in case of phlebitis, lymphangitis, and lymphadenitis which have not gone on to suppuration. This is combined with the use of wet dressings covered with rubber tissue or of ice. Mercurial ointment, which is to be rubbed in very gently, also does good service. During the further course one must be on the lookout for suppuration. If it develops, the pus is to be evacuated by a free incision.

For the treatment of erysipelas, see Principles of Surgery, page 348.

Every pus focus which manifests itself by a softened, fluctuating area is to be opened by an incision in the longitudinal direction of the forearm and drained. In case of deep collections of pus, the skin and the fascia are divided freely, and then a closed dressing forceps or an artery clamp pushed in. In case of extensive suppuration one should make too many incisions rather than too few. They are especially necessary at the upper and lower boundary of the pus focus. Undermined portions of skin are to be divided throughout their entire extent, sloughing tissue is to be removed, etc. The pus foci are drained from the bottom by short, thick drainage-tubes whose outer end, which is cut off short, is pierced with a safety pin, in order that the tube may not slip into the abscess cavity. Finally, the pus focus is thoroughly disinfected by irrigating it with 1-to-1,000 bichloride, and the arm placed upon a splint—e. g., a Volkmann's suspension splint (Fig. 730)—and covered with an antiseptic dressing. In case of extensive suppuration and sloughing, packing the incisions with sterile or iodoform gauze is to be recommended, and, if necessary, permanent irrigation (see Principles of Surgery, page 178), etc. It is often found necessary to amputate the septic limb in order to save the patient's life.

Diseases of the Tendons and Tendon Sheaths.—The forearm, especially the region of the wrist, is a favourite place for diseases of the tendons and tendon sheaths.

I. Diseases of the Sheaths of the Extensor Tendons. Dry Tenosynovitis.—By dry tenosynovitis is understood an acute inflammation of the tendons, especially the abductor longus pollicis, the extensor brevis pollicis, less often the extensor indicis and the extensor communis digitorum, above the wrist joint, which occurs in consequence of hard work with the hands, especially among laundresses, joiners, smiths, and persons in general whose calling demands rough labour; also among piano-players, etc. We have to do with an acute or subacute traumatic inflammation of the tendons named, in consequence of their friction over the surface of the radius. The principal symptom, as in dry pleurisy, is a characteristic dry creaking or a grating friction sound which is perceived by placing the hand upon the inflamed tendons and having the patient move the thumb and the wrist. The creaking is conditioned upon a hæmorrhagic and fibrinous exudation and a cellular proliferation within the tendon sheath. Aside from the grating friction sound, the area in question is painful and swollen, and the hand is more or less incapable of use for hard work. The course is favourable, and with proper treatment a rapid cure usually follows.

The treatment consists in daily massage, in the use of wet dressings that exert pressure, and immobilization of the arm upon a small splint

with the use of a sling. The wrist joint should be immobilized for only a few days, and passive movements are then begun. The inunction of mercurial ointment or the application of tincture of iodine with a brush is combined with the massage and passive movements. The hand is to be favoured for some time afterward, as otherwise recurrences easily occur.

Serous tenosynovitis usually begins as a subacute serous inflammation of the tendon sheath and is not so quickly cured as dry tenosynovitis, from which it often proceeds. It is not infrequently tubercular in character, and then runs a very chronic course, finally passing into the fungous form of inflammation. The favourite locations of serous tenosynovitis are the tendons of the extensor communis digitorum, the extensor pollicis, and especially the flexor tendons (see page 631). In case of tubercular inflammation, a characteristic swelling is found along the course of the tendons, and there are usually fistulæ later on and extensive fungous granulations, as well as caseous foci or abscesses.

Chronic tenosynovitis sometimes has a syphilitic origin, and one then finds in the course of the tendon sheaths the characteristic semi-soft, gummatous infiltrations. The history of the case or other indications of syphilis lead to a correct diagnosis.

So-called rice bodies are sometimes found in inflamed sheaths in varying numbers. They are usually to be regarded as albuminous products of coagulation (Meckel, Lücke, Volkmann), and are less frequently organized formations of connective tissue or cartilage which have arisen from hypertrophy of villous outgrowths from the serous lining of the tendon sheaths.

We have already spoken of suppurative tenosynovitis on page 627.

Treatment of Serous Tenosynovitis.—Prompt operative treatment is indicated in case of tubercular tenosynovitis. The tubercular tissue should be thoroughly extirpated and scraped out, and there should be no hesitation in opening the sheath freely, in order that all the diseased tissue may be removed. The after-treatment consists in drainage, suture, placing the forearm upon a splint, and applying an antiseptic protective dressing. In case the process is extensive the arm is elevated (see Fig. 730, page 628), and the patient must lie in bed for some days. In dealing with patients who dread the knife, one may inject ten-per-cent iodoform oil or iodoform-glycerin (one or two hypodermic syringefuls or more every week or two, according to the degree of the affection). After healing has taken place the function of the tendons is to be restored by baths, active and passive movements, massage, and electricity.

In gummatous (syphilitic) tenosynovitis also an active local treat-

ment by incision, scraping out, and extirpation of the gummatous infiltrate is to be recommended in addition to that of a general anti-syphilitic character.

Simple chronic serous tenosynovitis is treated in the same way as dry tenosynovitis (massage, passive movements, mercurial ointment, tincture of iodine, etc.). It is always to be borne in mind, however, that chronic serous tenosynovitis is sometimes conditioned upon tuberculosis, and massage is then decidedly to be avoided. Every simple tenosynovitis which is at all obstinate is best cured by incision, and any rice bodies that may be present are removed in the same way.

After the cure of every affection of the tendon sheaths, especially when treated by operation, the after-treatment, consisting of active and passive movements, baths, massage, and electricity, is important.

II. Diseases of the Flexor Tendons and Tendon Sheaths.—The same inflammations occur here as in the extensor tendons. The clinical picture of the inflammations of the flexor tendon sheaths, however, is very essentially modified by the fact that the flexors of the fingers are united in a common bundle at the wrist by loose connective tissue, while the extensor tendons take a more isolated course. Rosthorn has made a special study of the synovial sacs and tendon sheaths of the palm of the hand. According to this authority, two synovial sacs, separated by a septum, are found regularly under the transverse carpal ligament, a radial and an ulnar, of which one communicates only with the tendon sheath of the flexor pollicis and the other only with the sheaths of the flexors of the little finger and perhaps the middle finger also, while the superficial and deep flexor tendons of the index and middle fingers lie entirely outside the two sacs. They are surrounded by loose cellular tissue or have closed synovial sheaths. Rosthorn has never seen a communication between the radial and ulnar synovial sacs, nor any open connection between the synovial sacs and the joints. Both synovial sacs, being constricted by the tense transverse carpal ligament, have the form of an hour-glass when they are in a distended condition. Their size is subject to individual fluctuations, but, generally speaking, they extend from the level of the radio-carpal joint to a point above the metacarpo-phalangeal joint in question.

The inflammations of the cellular tissue and the synovial sacs and tendon sheaths of the flexor tendons are of great practical importance.

Acute suppurative inflammation of these synovial sacs and tendon sheaths may be traumatic in origin, but is due in most cases to the secondary extension of inflammations of the fingers in the vicinity of the flexor tendons. Some infections are very severe, and usually lead

to extensive necrosis of the tendons and spread with great rapidity in the intermuscular spaces of the forearm.

In mild cases acute non-suppurative inflammation of the synovial sac is treated by elevation upon a splint (see Fig. 730, page 628) and the use of ice. If there is no improvement, and if suppuration is threatened or already exists, the sac is opened above and below the transverse carpal ligament by means of free incisions, gauze drainage is inserted, and an antiseptic dressing applied. The arm should then be kept elevated. Careful attention must be paid to any burrowing of pus in the direction of the forearm.

Among chronic inflammations of the synovial sacs and tendon sheaths of the flexor tendons, chronic serous inflammation is the commonest form, which here also, as on the extensor side of the forearm, is sometimes caused by certain kinds of work, but is often of a tubercular nature. In case of more marked serous effusion within the large palmar synovial sac, a tense fluctuating tumour of the characteristic hour-glass form is seen above and below the transverse carpal ligament. The contents of one swelling can be pressed in part into the other. Distinct crepitus is not infrequently demonstrable, and the rice bodies mentioned on page 630 are often found in the sac, partly in the form of albuminous products of coagulation, partly as cast-off villous proliferations in connection with inflammatory, hyperplastic degeneration of the inner wall of the synovial sac. The further course of serous inflammation of the synovial sac is often very protracted if suitable treatment is not entered upon.

Serous inflammations of the synovial sacs and tendon sheaths are sometimes conditioned, as has been said, upon tuberculosis, and are the preliminary stage of a fungous (tubercular) inflammation, with the formation of a characteristic grayish-white granulation tissue permeated with tubercles and caseous areas.

The treatment of chronic inflammation of the synovial sac consists in evacuation of the sac by incision above and below the carpal ligament, with subsequent extirpation of any degenerated portions of the wall, drainage, and the application of an antiseptic protective dressing. The arm is immobilized upon a splint and given a vertical elevated position. Simple puncture, with or without the injection of tincture of iodine, is sometimes uncertain and sometimes more dangerous than aseptic incision. Compression and massage are not sufficient. In case of tubercular inflammation the diseased parts of the wall are to be carefully excised with scissors and forceps; and here also, if necessary, injections of ten-per-cent iodoform oil or iodoform-glycerin are to be recommended. Great care is necessary in working in deeper, in order

that the tendons lying in the fungous masses of tissue and the median nerve may not be injured.

Ganglion.—By ganglion is understood a small cystic, more or less movable tumour, which is often very hard, and occurs most frequently on the dorsum and the radial side of the wrist and the dorsum of the hand, less often on the palmar side. It varies in size from a pea to a walnut, or may be even larger. It is sometimes spherical in form and sometimes more uneven or lobulated. It is usually soft and fluctuating on palpation, but may be, on the other hand, very tense or even as hard as bone. The contents are usually gelatinous, having about the appearance of the vitreous humour of the eye, or they may be yellowish like honey.

Different kinds of ganglia may be distinguished according to their origin. Some of them are dilatations of the tendon sheaths, which protrude through slits either preformed or traumatic in the posterior annular ligament or above and below the same. This form of ganglion sometimes arises suddenly—e. g., after a sprain of the wrist, and then gradually increases in size, while others develop without any definite cause. They either remain in open communication with the tendon sheath or are completely shut off from it. They are to be regarded in part as colloid cysts of the tendon sheaths (Michon, Henle).

A second variety of ganglion originates in the joints of the wrist, and arises in two different ways. They are either hernial protrusions of the synovial membrane of the joint, which may be completely separated from the latter, or they arise from the dilatation of small follicular synovial cysts. Gosselin regards them essentially as retention cysts, which originate in the recesses of the synovial membrane. Some of these latter ganglia are, no doubt, like those on the tendon sheaths, to be explained as colloid cysts (Teichmann).

The third (least common) kind is the bursal ganglion, which arises from dilatation and protrusion of a portion of the wall of a normal or accessory bursa in the region of the wrist.

As has been already mentioned, all ganglia are either in open communication with a tendon sheath, joint, or bursa, or they are completely shut off from the same. Their contents are hence sometimes reducible and sometimes irreducible. Many ganglia disappear again as they came, while others remain stationary or grow with more or less rapidity. I have removed small ganglia of the size of a pea from the tendons of the fingers of pianists which greatly interfered with the movement of the fingers in playing. There is often no discomfort whatever. One sometimes supposes that he is dealing with a ganglion, and finds upon operating that he has to do with a circumscribed tubercular in-

flammation of the tendon sheath, the periosteum, or the bone, or with a sarcoma, myoma, etc., of the tendon sheath (Billroth, Czerny, the author). Ganglia not infrequently occasion very troublesome neuralgia, especially on the palmar side of the hand and fingers, in consequence of traction on and compression of the nerves (see page 666).

The best and surest treatment of ganglia is aseptic excision of the sac. Subcutaneous rupture of the ganglion, which is best accomplished by placing a seal upon it and striking it with a hammer, and the subsequent application of a compressive dressing for a few days, is much less certain in its results, recurrences being the rule. The same is true of subcutaneous division of the sac with a tenotome parallel to the tendons, the skin being pushed to one side. Puncture with the injection of tincture of iodine is to be discarded altogether, as it may be followed by severe inflammation or even suppuration.

Inflammations of the Bones of the Forearm and the Wrist.—Acute periostitis occurs especially after injuries and in the course of a deep cellulitis. Acute osteomyelitis of one or both bones of the forearm in connection with multiple infectious osteomyelitis is not so frequently observed as on the humerus. Its course is sometimes slow and sometimes very acute, terminating in suppuration, separation of an epiphysis, and extensive necrosis. Necrosis of the ulna extending into the elbow joint has been observed especially among children. The bone can, however, be completely regenerated without interference with the function of the elbow (König, Volkmann).

Chronic periostitis and osteomyelitis resulting from tuberculosis, especially near the articular ends of the bone, are more common. These processes break through externally, it may be, and run their course with or without secondary involvement of the neighbouring joint. The treatment consists in promptly chiselling open or scraping out the diseased end of the bone before the joint is infected. Schede's method of healing under an aseptic blood clot usually gives good results.

Gummatous (syphilitic) periostitis and osteomyelitis are more frequently observed in the ulna than in the radius. A general antisyphilitic treatment (iodide of potassium, mercury) is to be adopted as well as suitable and energetic treatment of a local character.

The power of regeneration of the radius and the ulna after inflammatory processes and necrosis, even necrosis of the whole shaft, is usually, as has been said, very good. In case of large defects in the bone one may either form pedunculated flaps of periosteum and bone from one or both stumps and turn them into the defect, or transplant young bone or cartilage from animals, with the use of aseptic methods (see Principles of Surgery, page 586). In case of a large defect in one

bone of the forearm, the ends may be approximated after resection of the other bone.

Tumours of the Forearm and the Wrist.—Lipomata, fibromata, neuromata, and angeiomata occasionally occur in this region. Lipomata are found upon the forearm and the wrist, especially in the diffuse form along the sheaths of the tendons. Neuromata are probably the most common. They not infrequently occur as multiple neuromata and plexiform neuromata, and they sometimes form large tumours combined with hypertrophy of the skin (elephantiasis). Neuromata and neurofibromata of the forearm are also observed in the form of the so-called tubercula dolorosa—that is, painful

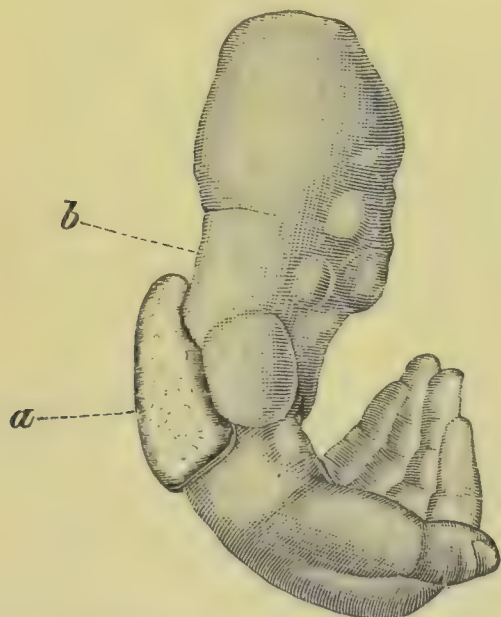


FIG. 731.—Multiple recurrent neuromata of the forearm. Most of the nodules lie beneath the skin: *a*, ulcerating nodule; *b*, cicatrix from previous excision of the primary neuroma (Virchow).



FIG. 732.—The hand of a paraffin worker forty-five years of age which is covered with pustules, scabs, and papillary growths. An epithelioma developed in one of the ulcers, and was followed by amputation of the forearm and death from general carcinosis.

nodules, from the size of the head of a pin to that of a bean, along the course of the cutaneous nerves, or as tumours, from the size of a pea to that of a hazelnut, on the larger nerves of the arm. Malignant neuromata—that is, those which recur after extirpation or form metastases (Virchow, Volkmann, see Fig. 731)—also occur. The continuity of the nerves can usually be preserved in the extirpation of neuromata. If this is not possible, the nerve stumps are united by suture or neuroplasty (see page 607). The treatment of plexiform neuromata, which involve a number of branches of a nerve, can in some cases be only

palliative. In case of malignant neuromata and multiple tumours, amputation is indicated.

The treatment of neuralgia of amputation stumps and amputation neuromata consists in excision of the latter with removal of a large piece of the involved nerve trunk.

Of malignant tumours, epitheliomata are found frequently among tar or paraffin workers (Fig. 732; see also *Principles of Surgery*, page 778).

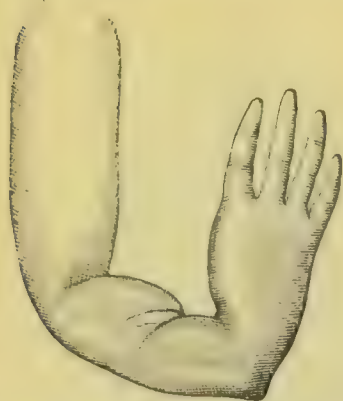


FIG. 733.—Defect of the radius with club hand and absence of the thumb (Voigt).

Primary carcinomata of the extremities arise partly from chronic inflammatory processes of the cutaneous coverings, within cicatrices in the soft parts, in the bottom of old bone sinuses, from congenital, soft warts or such as have arisen in the earliest childhood, from angiomas or moles, or, finally, spontaneously upon skin which was heretofore apparently normal (Rudolph Volkmann). Metastatic carcinomata from a primary carcinoma in a different part of the body have been observed in very rare cases upon the forearm and upon the extremities in general.

Sarcomata of considerable size and very rapid growth sometimes develop in the fascia, the peritendinous tissue, or the periosteum. In every case of malignant tumour, amputation of the forearm or the upper arm is indicated.

Lupus of the forearm and the hand may be very extensive. The treatment consists in excision of the lupoid area and in the use of the sharp spoon with subsequent skin-grafting, the thermo-cautery, etc. (see also *Principles of Surgery*, page 517).

We have already mentioned aneurisms on page 609.

Malformations of the Forearm and Wrist.—As regards congenital malformations, complete or partial absence of the forearm is sometimes observed, so that the stump of the arm ends at the elbow or in the forearm. We have to do in these cases with a disturbance in development or with a spontaneous amputation of an already existing forearm—e. g., by constricting amniotic strands. Schrader has made a special study of these defects, and comes to the conclusion that the disturbances in development are caused by amniotic adhesions or the umbilical cord; perhaps also by obliteration of blood-vessels and anomalies of the central nervous system, while the true spontaneous amputations are due to the constriction of amniotic strands or the umbilical cord and gangrene. I mention, finally, the complete or partial absence of one bone of the forearm—e. g., the radius—with secondary club-hand, in which the thumb is usually wanting (Voigt, Gurlt, Fig. 733). Complete or partial absence of the ulna is very rare, and the ulnar half of the hand is then usually wanting, so that the latter consists only of the thumb and the forefinger. Congenital dislocation of the radio-carpal joint and contractures

of the hand in consequence of congenital palsies are also of very rare occurrence.

§ 304. **Diseases of the Wrist and Carpal Joints.**—The anatomy of these joints as given in § 298, page 619 ff., is of great importance with reference to the origin and the extension of inflammations. As we saw on page 620, the mid-carpal joint communicates with the carpo-metacarpal joint and exceptionally with the radio-carpal joint, so that acute inflammation of the mid-carpal joint may lead to general inflammation of the whole carpus. We have also seen that the lower radio-ulnar joint, the joint of the pisiform bone, and the joint between the metacarpal bone of the thumb and the trapezium are independent articulations. For the sake of simplicity we shall here take up all the larger joints together, and consider first the inflammations of the radio-carpal joint, then those of the mid-carpal joint and the common carpo-metacarpal joint.

Acute suppurative inflammation of the radio-carpal and carpal joints occurs especially after penetrating wounds of the joints which have not run an aseptic course, particularly after gunshot wounds with shattering of the carpal bones, after severe injuries from machinery, etc. In most cases of acute suppurative inflammation of these joints the adjacent tendon sheaths soon become involved. Restriction of movement or ankylosis usually ensues after suppurative inflammation, but the hand is nevertheless well capable of use if it is in a good position and the flexor and extensor tendons of the fingers are not fixed.

The most frequent joint-inflammation in the region of the wrist is that occurring in acute articular rheumatism. Aside from what has already been said, the symptoms and the course of the different forms of acute inflammations of the joints of the wrist and carpus are without peculiarities. The reader is therefore referred for a more complete statement to Principles of Surgery, § 113, page 658 ff.

The treatment of the different forms of acute inflammation of the joints conforms to general rules (see Principles of Surgery, page 664 ff.). Acute non-suppurative inflammations are treated by immobilization of the joint upon a splint, elevation, the use of ice, etc. In all cases of suppurative inflammation provision should be made as early as possible by drainage of the joint for a free escape of pus, without resection or with as restricted resection as possible. Every injury of a joint should be treated under strictly aseptic methods, combined with careful disinfection, drainage, and elevation of the joint (see page 628, Fig. 730). Primary amputation is often necessary in case of gunshot injuries and in all compound fractures with severe crushing of the car-

pal bones and particularly of the soft parts. Amputation should be performed, however, only in the worst cases. With the aid of aseptic methods we are able to preserve many a hand which would formerly have been amputated. In resections of the wrist joint also one should proceed as conservatively as possible. If suppuration already exists, an examination should be made for any periarticular, peritendinous, and intermuscular collections of pus in order that these also may be sufficiently opened up and drained. If the fever continues and the wrist joint becomes loose, the question arises whether resection or amputation is to be performed. The latter should be avoided here also as far as possible.

In all inflammations of the wrist joint and the carpus care is always to be taken that healing takes place with the hand in a good position. Any stiffness of the joint, the fingers, etc., should be overcome by making use, after healing, of active and passive movements, massage, baths, etc.

Gout.—Gout is frequently located in the joints of the hand and fingers among old people, especially those of the higher classes, and is characterized by very painful inflammations of the joints, which appear in the form of attacks. It begins with a serous effusion and the formation of crystalline deposits about the joint, which consist especially of sodium urate and of combinations of uric acid with lime, magnesia, ammonia, and hippuric acid. The skin is much reddened and very tender even on the slightest pressure. Marked deformity of the joints, due to fibrillation and erosion of the cartilage and thickening of the articular capsule and the periarticular tissue, may finally develop with the increasing frequency of the attacks, with corresponding functional disturbances. Chalky deposits (tophi) are also formed about the joint.

The local treatment of gout consists, above all, in the alleviation of the pain by elevation of the hand and moderate compression of the inflamed joint by means of a dressing of cotton, warm fomentations, and a splint. Salicylate of soda is given internally. Diaphoretic remedies are thought to be efficacious in shortening the attack. The general treatment consists in a light diet and abundant fluids (Moselle wine and seltzer). The gouty diathesis is treated by prescribing a temperate mode of life, especially as regards alcohol, diminution in the amount of meat, also the use of saline springs (Carlsbad, Kissingen, Marienbad, Vichy, etc.), and the hot baths at Gastein, Teplitz, Wiesbaden, etc.

Acute inflammations of the joints, coming on in the form of attacks, are occasionally observed also in the course of chronic lead poisoning. They have the same clinical course as gout.

Among chronic inflammations of the wrist, tubercular arthritis is the most common (see Principles of Surgery, § 83, page 406 ff., and § 114, page 672 ff.). Tubercular arthritis of the wrist usually begins in the bone, less often in the synovial membrane. It sometimes arises

secondarily from tuberculosis of the tendon sheaths which has been neglected. Tubercular disease of these joints, especially among adults, is usually unfavourable, and the patient often does not come under treatment until caries is already well advanced, one carpal bone having infected another. Such individuals often have tuberculosis of other organs, especially of the lungs. The course of tuberculosis is much more favourable among children. Tuberculosis of the wrist joint and the carpus usually begins very slowly, sometimes as tubercular serous synovitis, and sometimes chiefly as a characteristic enlargement of the bones. The typical spongy, fungous swelling in the neighbourhood of the wrist finally spreads over more of the region of the joints and often passes over rapidly to the tendon sheaths. The movement of the fingers is correspondingly restricted, and periarticular abscesses and pathological dislocations develop.

The treatment of tubercular arthritis of the wrist consists, in the earlier stages, in the intra-articular injection of ten-per-cent sterilized iodoform glycerin or iodoform oil (one to five grammes every two weeks), with immobilization of the joint by means of a splint of wood, plaster of Paris, or water-glass. A general strengthening treatment is of great importance. In advanced cases the carious bone should be thoroughly scraped out, and, if necessary, a typical resection performed. Amputation is often not to be avoided in cases of extensive destruction of the bone and when the patient has phthisis, but it should, of course, only be resorted to when absolutely necessary. Generally speaking, tuberculosis of the wrist joint among adults belongs to the most unfavourable forms of joint tuberculosis. Much better results can be secured among children by injection of iodoform and scraping out the joint. Resection is here to be avoided.

Chronic (Employment) Arthritis of the Wrist.—Madelung has described a peculiar form of chronic arthritis among a certain class of workmen which leads to subluxation of the radio-carpal joint (Fig. 734). We have sometimes to do among such workmen with a relaxation of the ligaments and the capsule of the wrist



FIG. 734.—Subluxation of the radio-carpal joint from employment arthritis (Madelung).

joint and subluxation of the hand in consequence of continuous forcible movements of the wrist joint. In other cases, however, the firmness of the radio-carpal joint is not impaired, but the deformity, the subluxation, is conditioned more upon a disturbance of growth in young persons. There

gradually takes place in such young, growing persons, in consequence of violent movements, an alteration in the articular surface of the radius. It becomes oblique and growth is checked on its palmar portion which is subjected to the most pressure, while at the same time a hypertrophy of the dorsal border gradually develops (Fig. 734). The abnormal position of the hand becomes permanent in this way—that is, the hand retains its partial palmar dislocation. The main disturbance from the deformity developed after the cessation of growth consists in a corresponding interference with dorsal flexion. The pain gradually disappears and the patients finally become accustomed to the abnormal position of the hand.

One should call the attention of patients in the first stages of employment arthritis to the importance of avoiding, as far as possible, extreme forcible movements of the wrist, and any work which demands continued or severe pressure on the articular capsule and the palmar portion of the articular surface of the radius. For this purpose the wearing of splints or cuffs of sole leather is especially to be recommended.

Partial or Complete Anchylosis of the radio-carpal and other carpal joints often follows the various inflammations of the wrist joint and the carpus, especially suppurative inflammations. The causes of this stiffness of the wrist are conditioned partly upon pathological conditions of the skin, the tendons, and the fascia, and partly upon intra-articular changes, such as badly united fractures of the lower end of the radius, etc. In all cases of extensive injury to the soft parts, such as in burns and also in case of fractures, one should try, by way of prophylaxis, to prevent functional disturbances of the joint by massage, active and passive movements, baths, electricity, etc. Malunion of fractures of the radius may be improved in some cases by refracturing the bone or by osteotomy. We have already sufficiently discussed all these questions earlier in connection with the different injuries and diseases, likewise also the contractures of the forearm and the hand resulting from disturbances of innervation or injuries of the nerves and ischaemic atrophy of the muscles. Anchylosis arising from fibrous, cartilaginous, or bony adhesions of the articular surfaces should be treated by resection of the joint when the same is in a bad position. Milder grades of stiffness of the joint are overcome by massage, active and passive movements, and manual correction, it may be, while the patient is under an anæsthetic. The development of partial or complete anchylosis can, however, very often be prevented by suitable treatment of the diseases and injuries of the joints and their surroundings. If this is not possible, the joint must, at all events, be kept in such a position as to make the hand useful, and for this purpose a suitable splint should be worn.

For the neuropathic diseases of the bones and joints in connection with syringomyelia, see *Principles of Surgery*, page 695.

§ 305. **Amputation of the Forearm.**—The circular method is especially adapted for amputation of the forearm, or, under some circumstances, a flap method with the formation of a posterior or a posterior and anterior skin-flap (see Principles of Surgery, pages 113–120). The muscles are divided close to the line of reflection of the skin-flaps by a circular incision, and the muscles lying between the bones, together with the interosseous ligament, are severed with a two-edged catlin which is inserted between the bones from the palmar side and then from the dorsal side and carried around the radius and the ulna. The soft parts are then retracted by means of

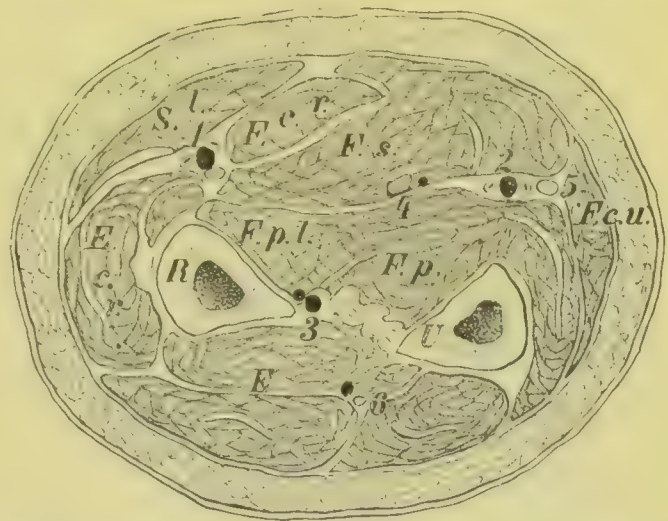


FIG. 735.—Transverse section through the middle of the forearm: *R*, radius; *U*, ulna; *1*, radial artery accompanied by two veins and the radial nerve; *2*, ulnar artery accompanied by two veins and the ulnar nerve (*5*); *3*, anterior interosseous artery; *6*, posterior interosseous artery with the posterior interosseous nerve; *4*, median nerve; *S.l.*, supinator longus; *F.c.r.*, flexor carpi radialis; *F.s.*, flexor sublimis digitorum; *F.c.u.*, flexor carpi ulnaris; *F.p.l.*, flexor pollicis longus; *F.p.*, flexor digitorum profundus; *E.c.r.*, extensor carpi radialis; *E*, extensors of the hand and fingers.

an aseptic compress passed between the bones. The latter are finally sawn through with the forearm in supination. The vessels to be tied are the radial and ulnar arteries, the two interosseous arteries, and various muscular branches. The anatomy of the wound is represented in Fig. 735. One should always, if possible, give amputation of the forearm the preference over disarticulation at the elbow, because a movable artificial forearm can be applied to a very small stump.

§ 306. **Amputation at the Wrist** is performed usually by means of the circular method.

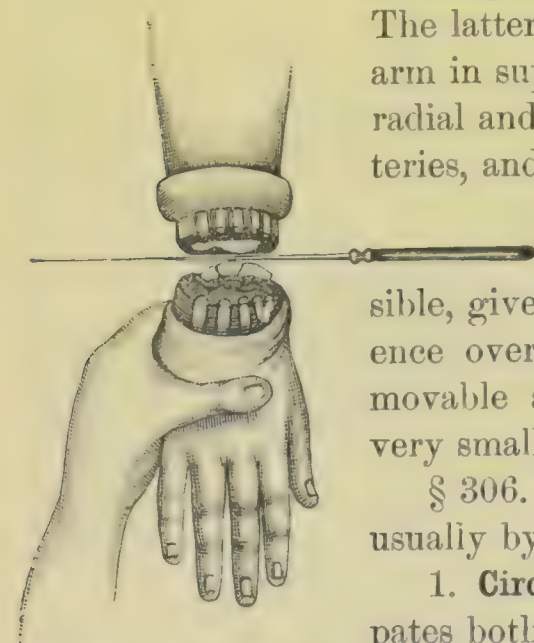


FIG. 736.—Amputation at the wrist (circular method).

1. **Circular Amputation.**—The operator palpates both styloid processes, and then, about two finger breadths below them, almost at the middle of the metacarpus, makes a circular incision through the skin, dissects up the latter, together with the subcutaneous fatty tissue, from the subjacent parts to a point above the styloid processes, and reflects it in the form of a cutaneous

cuff. The soft parts are then divided below the styloid processes by a second circular incision, the hand is abducted, the joint opened from the radial side below the styloid process of the radius, and the disarticulation completed (Fig. 736). The triangular interarticular car-



FIG. 737. — Amputation at the wrist by the radial-flap method of Du-brueil.

tilage of the ulna is removed in case it is diseased. If the covering of skin should not be sufficiently long, the styloid processes of the radius and the ulna can be removed. The radial and ulnar arteries, and perhaps the terminal branches of the interosseus arteries, are to be tied.

2. Flap Amputations.—The cutaneous flaps are chosen according to the situation of any defect in the soft parts—e. g., a dorsal flap or a dorsal and palmar flap; or, finally, the radial flap, after Du-brueil (Fig. 737), may be chosen, or a similar ulnar flap. The base of the radial flap takes in the radial third of the carpus, and its apex reaches the base of the first phalanx of the thumb.

§ 307. **Resection of the Wrist.**—Two methods are especially adapted for the resection of the wrist joint: the single dorsal incision, after Langenbeck, for complete resection, and two lateral incisions for partial resection—that is, for the resection of the lower ends of the radius and the ulna. In complete resection of the wrist the lower ends of the bones of the forearm are removed, as well as the carpal bones, with the exception, if possible, of the trapezium and the pisiform. The tendons are to be spared in every resection of the wrist, and this is best accomplished by the subperiosteal method. The relation of the tendons and the muscles, and of the radial artery on the radial side of the wrist joint, is shown in Fig. 738. On the ulnar side of the wrist joint the tendon of the flexor carpi ulnaris muscle, the ulnar artery and nerve, the flexor digitorum sublimis and profundus, the tendon of the extensor carpi

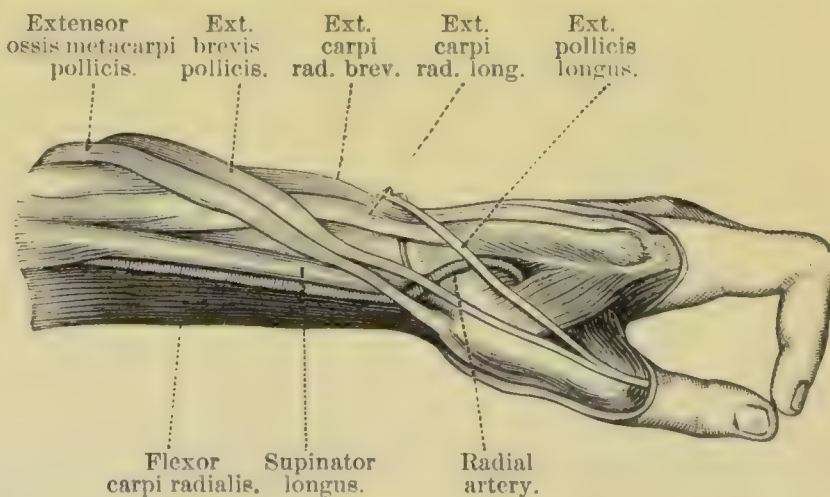


FIG. 738.—Relations of the muscles, tendons, and the radial artery at the left wrist (Helenle).

ulnaris, and the extensor digitorum communis, are especially to be considered.

1. Resection of the Lower Articular Surfaces of the Radius and Ulna by Means of Two Lateral Incisions (Fig. 739).—The longitudinal incision along the inner aspect of the ulna, from four to five centimetres in length, begins below the styloid process. The periosteum is divided between the extensor and flexor carpi ulnaris tendons and detached on all sides with the periosteal elevator, or chiselled off with some of the underlying bone. The lower end of the ulna which is thus exposed is now sawn off, answering to its diseased condition, with a metacarpal saw or chain saw, or bitten off with bone forceps and removed after the interosseous and internal lateral ligaments have been divided.

The second longitudinal incision, five or six centimetres long, on the outer side of the radius begins below the styloid process of the latter. It divides at first only the skin, in order that the tendons of the extensor brevis pollicis and abductor longus pollicis, the radial nerve, and the radial artery (see Fig. 738) may not be injured. The latter tendons are retracted in a dorsal direction, while the hand is brought into sharp dorsal flexion. The tendons named and all the extensors are best separated by chiselling away the periosteum with a layer of bone. The hand is then turned over, and while in supination the flexors are easily detached subperiosteally with the elevator. The end of the radius is displaced from the completely opened radio-carpal joint and then sawn off. If the carpal bones are not diseased they are left intact, or, in case of superficial disease, are scraped out. The resected joint is drained and covered with an aseptic dressing, placed upon a splint and immobilized.

This partial resection of the wrist joint was formerly, though without reason, not regarded with favour, but the results are very good. For the after-treatment, see page 645.

If the carpal bones are also extensively diseased, the following method should be employed :

2. Complete Resection of the Wrist Joint and the Carpus by Means of a Single Dorsal Incision, after Langenbeck (Fig. 740).—The skin incision, which is about nine centimetres long, begins at the middle of the ulnar border of the metacarpal bone of the index finger and runs upward over the carpus and the middle of the epiphysis of the radius

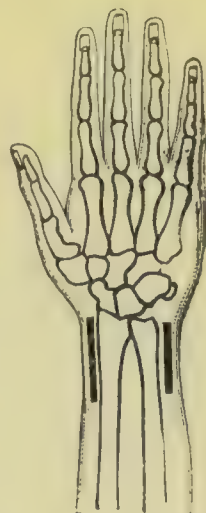


FIG. 739. — Resection of the lower ends of the radius and ulna by bilateral incisions.

(see Fig. 740). The incision is deepened on the radial side of the extensor tendon of the index finger, but without opening the tendon sheath, and higher up on the ulnar side of the tendon of the extensor carpi radialis brevis. This tendon is attached to the base of the third metacarpal bone. The posterior ligament of the carpus is divided between the tendon of the extensor longus pollicis and the extensor



FIG. 740. — Complete resection of the wrist after Langenbeck.

indicus as far as the edge of the epiphysis of the radius, and the joint capsule is then opened by a longitudinal incision, while the soft parts are drawn apart by means of retractors. The tendon of the extensor carpi radialis longior often interferes to such an extent with the progress of the operation that it must be chiselled off from the dorsal surface of the base of the second metacarpal bone (see Fig. 738). The capsule, which has been divided longitudinally, is now detached from the bone on each side, together with its ligaments and the tendons, by means of the periosteal elevator, aided by the knife or chisel, and the carpus is thus completely exposed. On the radial side the capsule and the tendon sheaths of the extensor longus pollicis, the extensor carpi radialis longior and brevis, and the supinator longus are detached and drawn outward, and then,

on the ulnar side, the tendon sheaths of the extensors—together with the posterior ligament of the carpus, the capsule, and the periosteum—are drawn inward. The wrist is now flexed, and the first row of carpal bones (scaphoid, semilunar, and cuneiform) are isolated from one another with a blunt-pointed knife or curved scissors and then prised out with a small periosteal elevator. The pisiform bone is left (see Fig. 727, page 619). The bones of the second row are then removed in the same way, with the exception, if possible, of the trapezium (see Fig. 727, page 619). Should it be necessary to remove this also, injury to the radial artery, which runs over the trapezium to the first metacarpal interspace, is, if possible, to be avoided. Finally, the ends of the radius and ulna, if diseased, are pushed out through the wound while the hand is in palmar flexion, laid free subperiosteally in the manner described above, and sawn or chiselled off or scraped out with a sharp spoon. Injury to the radial artery is also to be avoided in exposing the lower end of the radius. If the bones of the forearm are healthy they are, of course, left intact. If any tendons—e. g., in connection with gunshot wounds—are found to be divided, they are united by suture (see page 602). After completion of the operation there follow disinfection of the wound, drainage, suture

—e. g., in a transverse direction, for the purpose of shortening the long bridge of soft parts, or packing with sterilized or iodoform gauze with or without secondary suture—the application of an antiseptic dressing, and immobilization of the joint by means of a splint. Lister's splint, for example, is very serviceable (see *Principles of Surgery*, Fig. 179, page 208). The best way is to place the resected hand in about one third dorsal flexion on a splint (König, Bidder). The fingers should be freely movable. For the first few days vertical elevation is to be recommended. Even before the wound has healed, passive movements of the fingers are to be made, in order to prevent their becoming stiff. The more quickly the wound heals by primary union, the better usually are the functional results, because massage and exercise of the fingers in the proper way can then be undertaken very early. In favourable cases a normal functional ability is secured after resection of the wrist joint, so that patients can, for example, even play the piano again with the resected hand (Bergmann).

Complete resection of the wrist after Gritti makes it possible to remove the carpus together with the articular surfaces of the radius and the ulna in one piece. The trapezium and metacarpal bone of the thumb are preserved without exception. If they are also diseased, Gritti prefers amputation. The method is as follows: A radial incision is made, beginning two centimetres above the styloid process of the radius, extending to a point two centimetres beyond the base of the metacarpal bone of the index finger, and ending on its thumb side. An ulnar incision of the same length is made on the ulnar border of the dorsum of the hand. The two incisions are united by a transverse incision over the middle of the carpus. The extensor tendons are divided, the tendon of the extensor longus pollicis is preserved, and the two extensores carpi radialis and ulnaris are drawn to one side and detached from their insertions. The tendons that are severed are fastened to threads, and the flaps of soft parts are dissected back. The lower ends of the radius and ulna are then sawn off obliquely (more bone being removed from the radius than from the ulna), the carpus is detached from the soft parts of the palm of the hand, the joint between the trapezoid and the trapezium opened (the latter is preserved), and the carpus separated to a point beyond the bases of the four metacarpal bones. The latter are sawn off one centimetre below the carpo-metacarpal joints, and the extirpation of the carpus is thus completed. The radius is united with the second metacarpal bone and the ulna with the fourth by metallic sutures. Then follow suture of the tendon stumps, suture of the skin, and the application of a splint.

For the technique of bandaging the forearm and the wrist, see *Principles of Surgery*, §§ 50–55.

CHAPTER XXXII.

INJURIES AND DISEASES OF THE HAND AND THE FINGERS.

Congenital deformities (malformations) of the hand and the fingers (syndactylism).—Injuries of the hand and the fingers (soft parts, bones, joints—fractures and dislocations).—Inflammatory processes and other diseases of the hand and the fingers.—Cellulitis.—Inflammation of the joints.—Various diseases of the nails, the skin, the tendons, and the bones.—Chancre, syphilis, tuberculosis.—Inflammation of the joints.—Ganglion, etc.—Gangrene of the fingers.—Contractions of the fingers.—Dupuytren's contraction.—Trigger finger.—Writer's cramp.—Tumours of the hand and fingers.—Operations on the metacarpus and the fingers (resection, amputation, and disarticulation).—For the technique of bandaging the hand and the fingers, see Principles of Surgery, §§ 50–55.

§ 308. **Congenital Malformations of the Hand and the Fingers.**—The greatest variety of congenital malformations of the hand and fingers has been observed, but only a portion of them is of surgical interest.



FIG. 741. — Syndactylism with rudimentary development of two phalanges (H. Fischer).

One of the most important malformations of the hand is syndactylism (Fig. 741)—that is, the partial or complete fusion of two adjacent fingers, less often of all the fingers. Fusion of the thumb and the index finger is the most rare, and that of the middle and ring fingers is the most common. The web may consist of the soft parts only—that is, of the skin—or it may contain bone as well. Syndactylism, which is sometimes combined with other malformations of the hand, is to be regarded essentially as arrested development—that is, the division into the

separate fingers has, in consequence of some pathological causes, either not taken place at all or it has been only partial.

Treatment of Syndactylism.—The webs consisting of skin alone and especially such as are partial are, of course, the most favourable for

treatment. If there is bony fusion of the fingers, and if there is only one nail, it is impossible to overcome the malformation, because an independent articulation of the fingers is then wanting. A number of methods have been recommended for use in dealing with this deformity. The bloodless methods of treatment (division of the web by a ligature, clamp, etc.) have been altogether abandoned. The most useful operation is the division of the cutaneous web by an incision and the implantation of a cutaneous flap, after Zeller, Kern, Dieffenbach, and Didot, or with subsequent skin-grafting, in order to prevent the divided surfaces of skin from adhering again. Zeller forms a triangular cutaneous flap, whose base answers to the commissure which is to be covered and whose apex is directed toward the finger tips. This cutaneous flap is dissected up from the subjacent parts, whereupon the web is divided and the flap sutured between the first phalanges at the site of the normal commissure. Didot forms a flap from the palmar and one from the dorsal surface of the web, as shown in Fig. 742, passes each between the divided fingers, and sutures them to the denuded surfaces. During the after-treatment the fingers are to be kept upon a splint and separated by means of iodoform gauze.

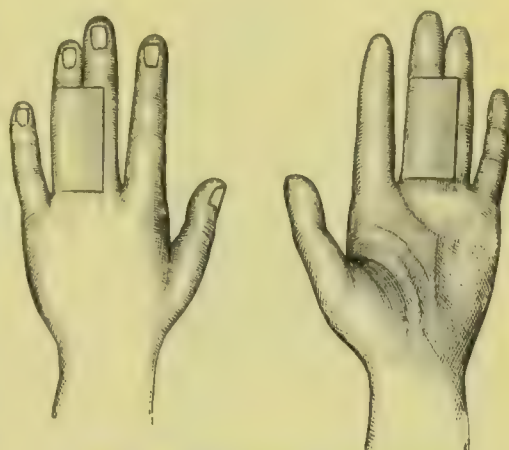


FIG. 742.—Didot's operation for syndactylism.

The opposite of syndactylism—viz., an abnormal cleft of the metacarpus or the fingers sometimes as far up as the carpus—is very rare, and is usually combined with other malformations of the hand (syndactylism, absence of a finger, etc.).

Congenital Macroductylism.—Congenital hypertrophy of the fingers, the hand, or an entire upper extremity (see Principles of Surgery, page 649, Figs. 360–362) appears in two forms. We either have to do with a symmetrical enlargement of the bones and the soft parts or the hypertrophy is conditioned upon lipomatous or cavernous tumours of the soft parts. This distinction is important from a therapeutic point of view. If a too thick or too long finger, resulting from symmetrical hypertrophy of the bones and the soft parts, does not impair the function of the hand, treatment is unnecessary. In case the hypertrophy arises from tumour formation in the soft parts, the attempt should be made to remove the tumour, or the entire finger should be amputated in case the function of the other fingers is impaired thereby or the tumour threatens to extend to the other fingers. It is, however, to be considered that this giant growth, especially that resulting from lipomatous or cavernous tumours in the soft parts, sometimes remains stationary, or may even disappear of itself, as, for example, in a case that I ob-

served. The giant growth conditioned in this case upon a cavernous angioma completely disappeared of itself in a year.

Elongation of a finger from superfluous digits is to be distinguished from giant growth proper. The opposite is brachydactylism, or congenital shortening of a finger by a reduction in the number of digits (Fig. 743). The ab-



FIG. 743.—Different varieties of deformities of the hand (Mosengeil).

sence of entire fingers or sections of the hand is called ectrodactylism (Fig. 743). When there are defects in the fingers, the bones observed above are usually defective as well—e. g., there is a defect in the radius in case of absence of the thumb (Davaine).

Regarding the change in the form of the fingers attending acromegaly and acromicria, see Principles of Surgery, page 650.



FIG. 744.—Absence of the distal phalanx of the second, third, and fourth fingers. Circular constriction of the thumb (Mosengeil).

Defects in the fingers and in the hand are sometimes conditioned upon intra-uterine constrictions, upon so-called spontaneous amputations—e. g., the upper arm, the forearm, or single fingers may be tied off by amniotic cords, by adhesions with the amnion, or by the umbilical cord. In Fig. 744 the terminal phalanx and the nail are wanting on the first three fingers in consequence, probably, of intra-uterine constriction. On the



FIG. 745.—Congenital constriction furrows on the third and fourth fingers in a male child thirty-eight days old.

thumb there is only a circular furrow, as complete constriction was not reached here. The congenital furrows from constriction are still more distinct in Fig. 745. In such cases a complete separation at the point of constriction may ensue after years or in later life in consequence of deepening of the furrow, so that the digits in question fall off of themselves or the decayed bone breaks off in consequence of a slight injury. Menzel reported a very characteristic case of this kind. It was that of a woman with con-

genital defects and constriction furrows on her hands, who, in her forty-fourth year, lost the greater part of her right middle finger at the point of constriction (Fig. 746). The greater part of the last two fingers of the right hand were wanting, and there was also a congenital constriction furrow on the index finger. On the left hand there were only a normal thumb and index finger. The feet also were deformed like the hands. Otherwise normally formed fingers—the thumb, for example—are sometimes attached to the metacarpus only by a thin cord of tissue.

The occurrence of supernumerary fingers or toes (polydactylism) is one of the most common malformations of the hand and the foot. Polydactylism has repeatedly been inherited in certain families for several generations. In the majority of cases this is conditioned, no doubt, upon a double germinal layer. The two very rare cases of Gruber especially favour this view, in which there were ten fingers on each hand and ten toes on each foot. The supernumerary finger is usually on the radial or ulnar side of the hand. In three fifths of the cases observed (one hundred and twenty-seven) there was a supernumerary little finger and in two fifths a supernumerary thumb (Gruber). Other malformations of the hand sometimes exist simultaneously. Different degrees of polydactylism are represented in Fig. 747. The mildest degree is the presence of two nails upon the terminal phalanx—e. g., of the thumb (Fig. 747, *a*). One may also find two terminal phalanges and very small finger-like appendages on the thumb and the little finger (Fig. 747, *b*). In



FIG. 746.—Spontaneous dactylolism in consequence of congenital constriction furrows in a woman forty-four years of age.

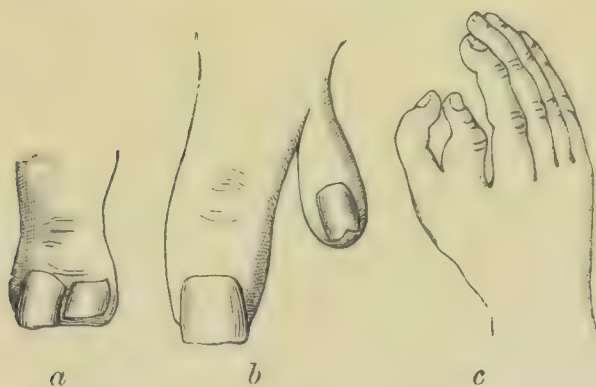


FIG. 747.—Different degrees of polydactylism (Annandale).

the higher degrees the supernumerary finger is fully developed (Fig. 747, *c*). It may also have its supernumerary metacarpal bone. The only treatment of polydactylism consists in the removal of a supernumerary finger in case it interferes in any way with the use of the hand.

I mention, finally, congenital deviations of the phalanges (clino-dactylism)—e. g., dorsal, palmar, or lateral malpositions of the same.

In case any functional disturbances are caused thereby, partial resection should be performed. Congenital contraction—e. g., flexion of this or that phalangeal joint—is sometimes observed, which can be overcome either by an operation, as, for instance, in Dupuytren's contraction, or gradually by permanent dorsal flexion by means

of a small apparatus after P. Vogt. This consists of two metallic rings which are joined on the dorsal side by a rubber band and on the palmar side of the fingers by a little rod with a hinge.

For club-hand, see page 636, Fig. 733.

§ 309. **Injuries of the Hand and Fingers.**—Injuries of the hand and fingers are very common, being caused in many cases by the great variety of machines which are used in our modern industries. If properly treated, they are very satisfactory cases.

Their treatment is to be carried out with the greatest care and under strictly aseptic methods. The amount of injury to the soft parts is, generally speaking, decisive regarding the outcome and the character of the treatment.

Every wound of the hand and the fingers is to be treated under strict antiseptic precautions. The injured hand if very dirty is to be most carefully cleansed in a bichloride bath (1 to 1,000) with soap, tincture of green soap, ether, and 1-to-1,000 bichloride, and to be thoroughly examined. The sensation and active mobility of the fingers should be tested in order to determine whether nerves or tendons are injured. For the treatment of injuries of the tendons and nerves the reader is referred to pages 602–608. Such injuries are not infrequently overlooked, so that secondary suture becomes necessary. All foreign bodies, especially fragments of glass, bits of wood, sand, earth, or dirt, are to be most carefully removed and rendered harmless by disinfection. I have several times removed good-sized foreign bodies from old fistulous tracts in the hand which were concealed under the superficial anterior carpal ligament. Wounds of the fingers which are soiled by earth or splinters of wood are sometimes followed by tetanus (see *Principles of Surgery*, page 354 ff.), and a careful disinfection is therefore necessary in such cases. Splinters of wood under the nail can generally be extracted without difficulty. The nail is to be cut away, if necessary, to a proper extent, or completely removed. If a finger nail is displaced, it should be removed altogether. One should proceed as conservatively as possible in dealing with all contused wounds of the fingers, and in case of crushing of the phalanges as much as possible should be retained. Contused wounds should not be sewed up too tight, but should be left partially open. If a part of a finger is completely torn away and the bone protrudes from the wound, enough of the stump of bone must be removed to enable one to cover it well with the soft parts. Broken-off foreign bodies that lie beneath the skin, such as splinters of wood and points of needles, are removed under local anæsthesia, the punctured wound being sufficiently enlarged, without injuring the subjacent tissues. Injuries of the nerves that

run a very unfavourable course are sometimes caused by punctured wounds and may occasion severe functional disturbances of the hand in consequence of progressive neuritis. I saw a case of incurable ascending neuritis, with increasing functional disability of the hand, consequent upon a punctured wound of the deep branch of the ulnar nerve made by a pen filled with ink, such that the use of the hand was finally lost in consequence of ulnar paralysis. Extravasations of blood beneath and behind the nail are best removed by a small incision behind the nail with the subsequent application of a dressing that exerts pressure, or, still better, by removal of the nail. The latter is divided in the middle line by means of a scissors, one blade of which is passed beneath it, and the halves are removed with an artery clamp. Local anæsthesia should be used. In case of a large defect in the skin, an effort is made to replace it by skin-grafting or by a skin-flap from the immediate vicinity, from the chest, etc. The after-treatment of every injury to the hand and fingers is to be carried out under strictly aseptic methods, and it is better to dress it too often rather than too infrequently, in order to avoid all danger of suppuration that may spread to the joints or the tendon sheaths. Stiffness of the fingers or joints is to be overcome by massage and systematic movements. In order to transform a thumbless hand into one capable of grasping objects, Lauenstein recommends sawing through the metacarpal bones of the index and little fingers at about the middle, bringing the two fingers into opposition to the middle and ring fingers by turning them toward the palmar surface and letting them unite in this position. Lauenstein used this method in the case of a sailor fifty years of age with satisfactory results.

Ligation of the Superficial Palmar Arch.

—The skin incision is made as shown in Fig. 748, 1 or 2. The incision 2 is the more common and is made as follows: The thumb is abducted and a straight line drawn from the metacarpo-phalangeal joint

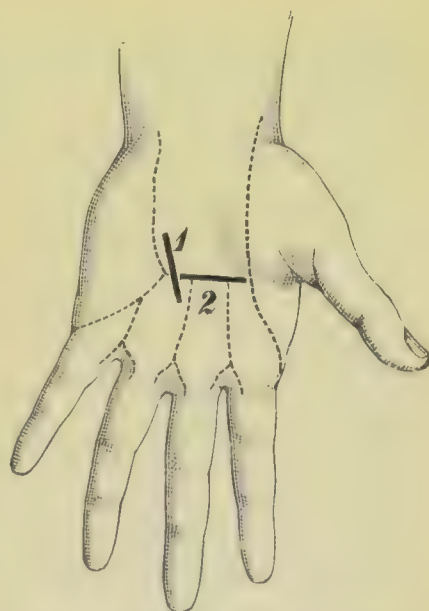


FIG. 748.—Ligation of the superficial palmar arch.

of the thumb parallel to the middle palmar crease as far as the lower border of the pisiform bone. A line running midway between this line and the palmar crease marks the position of the arch, which is easily found after dividing the skin, the subcutaneous fatty tissue, and the palmar fascia. It is separated by abundant adipose tissue from

the underlying nerves and tendons. One may also find the superficial palmar arch by means of the skin incision *I* (Fig. 748). A line is drawn from the middle of the base of the first phalanx of the middle finger to a point somewhat to the ulnar side of the centre of the middle palmar crease. The skin incision begins here and runs in the prolongation of this line obliquely upward about to the radial border of the hypothenar eminence.

In case of wounds of the deep palmar arch, its ligation involves too much injury, hence ligation of the accessible main trunks, together with compression of the wound, is therefore to be preferred.

Fractures of the Metacarpal Bones, which are not very uncommon, arise in most cases from direct violence, less often from indirect violence—e. g., from a fall or blow against the distal end of the metacarpus with the fist closed. The fracture occurs most frequently at the middle. Separation of the upper or lower epiphysis also occurs in young persons. Fracture is sometimes combined with dislocation. Fractures of the first, second, and fifth metacarpal bones are the most frequent. There is often no displacement of the fragments, or there may be an overriding or angular displacement, with the angle opening in the direction of the palm or the dorsum. The deformity that has been mentioned, the extravasation of blood, the localized point of tenderness, the abnormal mobility and crepitus are important in making the diagnosis. The head of the involved metacarpal bone usually projects toward the palm. The prognosis is favourable, generally speaking, though, to be sure, complete flexion of the hand or the involved finger may be prevented by overproduction of callus or malunion.

Treatment.—Any existing displacement is overcome by traction upon the finger and direct pressure. A firm wad of cotton is placed in the palm, and the hand is allowed to close over this. A gauze bandage is applied, which may be strengthened by one of plaster of Paris or water-glass. The first dressing is to be changed after six or eight days. The hand may also be immobilized upon a palmar or dorsal splint, and here also a rather thick pad of cotton is placed under the palm. The forearm is kept in a sling. Compound fractures are treated under antiseptic precautions and according to general rules.

Fractures of the Phalanges are in most cases compound. The line of fracture is usually transverse. Simple longitudinal fracture of the first phalanx of the last two fingers, in consequence of a severe blow against the phalanges with the fist clinched or from torsion, was observed three times by Krönlein. The phalanges are more frequently fractured by direct violence. Forcible stretching of the extensor tendons, in connection with extreme flexion of the fingers, may cause

avulsion of a piece from the last phalanx. The latter remains in such cases flexed and is incapable of active extension. Fractures of the phalanges usually unite in two or three weeks. Fractures near the joints or penetrating into a joint may occasion permanent functional disturbance of the articulation in question.

Treatment.—The finger is immobilized for two or three weeks by means of small splints of pasteboard, gutta-percha, wood, felt, leather, cellulose, etc., and the neighbouring fingers are likewise used as splints. Compound fractures should be treated as conservatively as possible. The fragments are united by suture of the periosteum with catgut. One should be on the lookout for any wounds of tendons. We have already mentioned on page 650 that in case of tearing off of a finger through a phalanx, the latter must be disarticulated at the next joint, or so far removed as to secure a sufficient covering of soft parts for the stump of bone.

Dislocations of the Carpo-metacarpal Joints of the Four Fingers.—As is well known, the carpo-metacarpal joints of the four fingers are united in a common articulation, while the carpo-metacarpal joint of the thumb is independent. Dislocations of the carpo-metacarpal joints of the four fingers are very rare. Hoffa mentions one case of backward and one case of forward dislocation of all four metacarpal bones. Isolated dislocations of one metacarpal bone are also of rare occurrence, with or without its fracture. The reduction of the dislocations of the metacarpal bones at the carpo-metacarpal joint is best accomplished by traction upon the hand with direct pressure or with combined dorsal or palmar flexion.

Dislocations of the carpo-metacarpal joint of the thumb are more common, especially dislocation forward, which is more frequent than backward dislocation. They are characterized by a corresponding dorsal or palmar projection of the dislocated metacarpal bone. Reduction is accomplished here also by traction and direct pressure. The function of the involved joint sometimes remains more or less impaired for a long time.

Dislocations of the Metacarpo-phalangeal Joints of the fingers are also rare. Those of the thumb are more frequent.

Posterior dislocation of the proximal phalanx of the thumb (Fig. 749), which is the more frequent, arises usually from violent dorsal flexion. The capsule is torn on the palmar side by the head of the metacarpal bone. The dislocation is sometimes complete and sometimes partial. Many persons can produce voluntarily an incomplete dislocation of the thumb at the metacarpo-phalangeal joint, and quite as easily effect its reposition. In dislocation of the thumb backward

the head of the metacarpal bone passes between the abductor brevis and the outer portion of the flexor brevis pollicis on one side, and the inner portion of the latter, and the adductor pollicis on the other side, and can be felt under the skin. The position of the thumb is essentially the same in complete and incomplete dislocation, and is very characteristic (Fig. 749). The proximal phalanx is usually perpendicular, but is sometimes in slight palmar flexion, especially when there is severe laceration of the ligaments. In the latter case the proximal phalanx usually deviates laterally also, especially toward the ulnar side. Active and passive movement in the metacarpo-phalangeal joint is completely suspended.

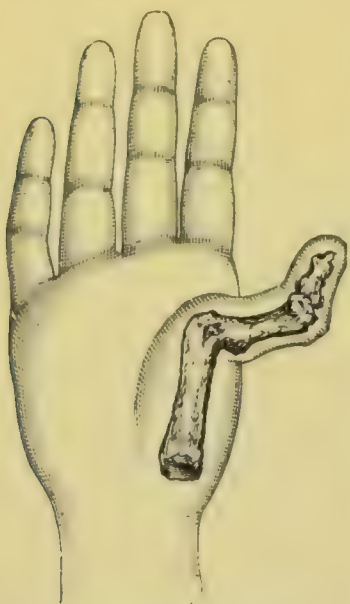


FIG. 749.—Posterior dislocation of the thumb.

The reduction of a backward dislocation of the proximal phalanx of the thumb is sometimes difficult, on account of the interposition of the sesamoid bones (Lücke, Farabœuf), of the tendon of the flexor longus muscle (Bardleben, Esmarch), or of portions of the capsule (Roser). It may also be prevented by the tension of the lateral ligaments or by the firm claspings of the metacarpal bone by the muscles of the thenar eminence. König found as an obstacle to reposition, interposition of the outer part of the articular surface of the phalanx which had been broken off. Reduction, however, is usually effected with ease, there being difficulty in about one third of the cases.

The reduction of a backward dislocation of the thumb is best accomplished by pushing the proximal phalanx of the thumb directly forward (Farabœuf), or by hyperextension with subsequent palmar flexion. Traction and forcible flexion should never be employed, because the interposition of the outer sesamoid bone between the phalanx and the metacarpal bone is favoured thereby as well as torsion of the sesamoid bone (Farabœuf's complex dislocation). In the latter the proximal phalanx of the thumb is in less marked dorsal flexion. In these complex dislocations Farabœuf recommends first overcoming the interposition and torsion of the outer sesamoid bone by traction and dorsal flexion, and then completion of the reduction in the manner just described.

The slings and forceps recommended for the reposition of backward dislocations of the thumb—e. g., those of Mathieu, Collin, or Luer—can always be dispensed with. A band of ribbon tied in the form of

a figure-of-eight knot would always be sufficient in difficult cases. If reduction does not succeed, or if one has to do with an old unreduced dislocation, the obstacle to reposition should be removed by aseptic arthrotomy, or, it may be, resection of the head of the metacarpal bone should be performed.

The after-treatment of a reduced dislocation of the thumb consists in fixation of the joint for ten days or a fortnight by means of a small splint of pasteboard, leather, wood, cellulose, etc. The normal mobility is then restored by massage and active and passive movements.

Forward dislocation of the proximal phalanx of the thumb (Fig. 750) is very rare, and results usually from forcible palmar flexion with abduction, adduction, or rotation. The thumb usually deviates somewhat in a radial or ulnar direction at the same time. The head of the metacarpal bone can be felt on the dorsum of the hand as a distinct prominence, and the base of the first phalanx in the same way in the palm. Reduction is effected by traction, hyperextension, and direct pressure upon the dislocated bone.

Dislocations of the Four Fingers at the Metacarpophalangeal Joints are of rare occurrence. Backward dislocations of the forefinger and the little finger seem to occur most frequently. These backward dislocations arise usually from overextension, with or without rotation of the finger in question, and also from the action of direct violence—e. g., upon the dorsal surface of the metacarpus. The forward dislocations, which are very rare, are produced mostly by the action of severe direct violence. The deformity is essentially the same as in dislocations of the thumb. In the majority of cases we have to do with compound dislocations. Reduction may be rendered difficult by the interposition or tension of the capsule, also by too small a rent in the capsule, and in case of dislocation forward by the interposition of the flexor tendons. In backward dislocations of the little finger similar obstacles to reduction are observed as in backward dislocations of the thumb. The reduction of backward dislocations of the fingers is effected by hyperextension (dorsal flexion), pushing forward of the proximal phalanx, and flexion. Traction, direct pressure, and flexion of the involved finger are to be recommended in case of forward dislocation. If the usual method of reposition does not succeed, in consequence of inter-

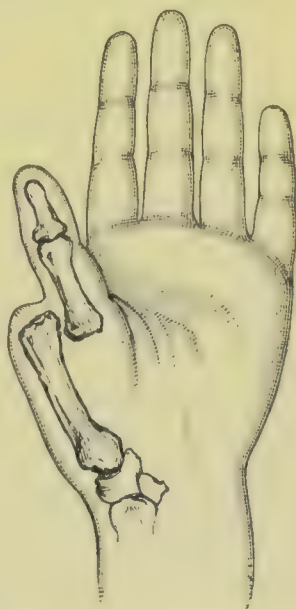


FIG. 750.—Anterior dislocation of the thumb.

position of the capsule, the joint should be opened and the obstacle to reduction overcome.

Dislocations of the middle and distal phalanges are very rare. Backward dislocations (Fig. 751, 1) arise from hyperextension. The still less frequent forward dislocations (Fig. 751, 2) are caused by hyperflexion. Lateral dislocations, also, to the radial or ulnar side have been seen to arise from rotation with abduction or adduction of the finger in question. The diagnosis of the individual dislocations is

easy, because the dislocated bones can be felt distinctly through the thin covering of soft parts. It is only in incomplete dislocations that the deformity is less pronounced.



FIG. 751.—1, posterior, and 2, anterior dislocation of the second phalanx.

The reduction of these dislocations can usually be easily effected by traction and direct pressure. An obstacle to reposition may be occasioned by interposition of the flexor tendons. The latter are

best freed by rotation of the phalanges. Resection may become necessary in case of compound dislocations, and if there is severe laceration of the soft parts, amputation or disarticulation may be indicated. The question of arthrotomy for irreducible subcutaneous dislocations seldom arises.

§ 310. **Inflammatory Processes and other Diseases of the Hand and the Fingers.**—We mention first the very frequent acute inflammation of the fingers, the so-called felon, which usually follows injuries, frequently of the most insignificant character. There usually develops at first a circumscribed suppurative inflammation—e. g., after a small punctured wound or a slight abrasion of the skin at the edge of the nail, or after a more serious injury of the finger. Servants, midwives, labourers of various kinds, and physicians are especially exposed to infection. A distinction is made between a superficial and deep felon. The superficial variety tends to extend to the deeper tissues and less along the surface. Deep inflammations in the vicinity of the tendon sheath extend more rapidly. The nature of the infection is of decisive significance as regards the course of the process. Infection by staphylococci, for instance, is more favourable than that by streptococci or the bacilli of malignant œdema, etc. (see Principles of Surgery, page 332). We have sometimes to do with specific infections—e. g., anthrax, tetanus, rabies, etc. (see particulars in Principles of Surgery).

The greatest variety of infectious processes, and even fatal general intoxication, occur not infrequently, and after slight injuries for the most part, among those persons who have to do with dead bodies or parts of dead bodies—e. g., physicians, anatomists, butchers, cooks, etc. The so-called cadaver poison is, no doubt, to a greater or less extent identical with the poison of putrefaction. It is a product of decomposition. Dead bodies may, moreover, contain specific microbes for a time after death—e. g., those peculiar to anthrax, sepsis, pyæmia, tuberculosis, etc. As the decomposition of the body progresses the specific microbes are overcome in the struggle with the saprophytic microbes and the products of decomposition. They are then no longer transmissible. This explains the fact that infections from cadavers vary greatly in their clinical course (see also *Principles of Surgery*, page 379).

In the mildest form of felon, arising from the inoculation of pus cocci into the rete Malpighii, there usually develops a circumscribed, superficial pustule, whose removal is followed, after the application of an antiseptic dressing, by prompt healing. Then comes the circumscribed cellulitis of the skin and the subcutaneous cellular tissue, usually on the palmar, less often on the dorsal, surface of the fingers. It is characterized by the formation of a localized and painful inflammatory infiltration, which leads to abscess formation and, under some circumstances, to progressive phlegmonous inflammation of the finger, to lymphangitis of the hand, etc. Lymphangitis manifests itself by the formation of characteristic red inflammatory streaks, which may spread over the hand and the entire arm as far as the axilla. The deep felons arise sometimes from primary deep infection of an injury of a finger and sometimes secondarily from the extension of a superficial process. Necrosis of the involved tendon and the bone results only too easily here if a means of escape is not provided for the pus by a prompt and free incision. These inflammations also spread easily along the surface and lead to severe cellulitis of the hand and the forearm, and to abscesses of the epitrochlear and axillary glands.

Acute inflammation of the finger joints also is sometimes primary, resulting from infection of the joint, or the joint may be attacked secondarily, in consequence of a periarticular suppuration (see page 659).

The worst variety of cellulitis of the fingers is the septic form, which often spreads with the greatest rapidity over the hand and the forearm, and may occasion very extensive destruction, especially of the tendons. Amputation of the forearm, or even disarticulation at the shoulder, may become necessary in the worst cases if energetic measures are not taken at the very beginning, by means of incisions, to prevent the extension of the inflammation. In other unfavourable cases

death from general sepsis ensues quickly without any demonstrable local inflammation to speak of at the point of infection.

Erysipelas of the fingers following infection from the erysipelas coccus is essentially a capillary lymphangitis of the skin and the subcutaneous tissue. The inflammatory redness of the skin spreads in a characteristic way with more or less rapidity, and without the development of suppuration. Erysipelas may, however, be complicated by abscesses or progressive suppuration (see Principles of Surgery, page 344 ff.).

The so-called erysipeloid is a disease of the fingers, unattended by danger, which arises from the infection of a wound among people who come in contact with animal matter—e. g., among butchers, tanners, cooks, oyster openers, etc. A burning, itching, inflammatory redness appears at the place of the injury with swelling of the involved finger, which gradually spreads, without fever, and seldom reaches the dorsum of the hand or the carpus; suppuration does not take place. Rosenbach and Cordua found a species of coccus to be the cause of the inflammation. The best treatment is the injection into the skin of a three-per-cent solution of carbolic acid.

It appears from what has been said that etiologically and clinically very different kinds of inflammation may attack the fingers. For a more detailed presentation of the different varieties of wound infection the reader is referred to Principles of Surgery. The prognosis of the inflammations depends upon the character of the microbes that are inoculated, partly also upon whether the inoculation is superficial or deep—e. g., into a tendon sheath, a joint, the periosteum, or a lymphatic vessel—and likewise upon whether or not the place of inoculation is at once recognised and thoroughly disinfected.

In treating the different acute infectious inflammations of the fingers, prophylaxis is of the greatest importance. Every wound or abrasion of a finger—even the smallest—should be thoroughly disinfected at once with solutions of bichloride, carbolic acid, etc. Physicians in particular, anatomists, and midwives can not be too careful in this respect. It is a good thing if a wound bleeds freely, as any microbes that have entered are likely to be washed out in this way. If an acute inflammation of the finger already exists, an immediate attempt should be made to check it by incision with subsequent disinfection, even if as yet there is no suppuration. It is a great mistake to await the latter, to allow the inflammation to become “ripe,” or to prescribe poultices. After the incision, which is made sufficiently deep and long and is performed under local anæsthesia, an antiseptic dressing is applied. I prefer to have the patient keep the latter wet with cold liquor

plumbi subacetatis dilutus for the first few hours. In case of extensive suppuration numerous incisions are made, and the deep collections of pus are opened up and drained. The hand should be immobilized upon a suitable splint, and in cases of severe cellulitis vertical elevation of the arm has usually a surprisingly favourable effect (see Fig. 730, page 628). In the further course, one must always be on the lookout for possible retention and burrowing of pus. The removal of the affected finger or of the hand or the forearm is often necessary in cases of severe septic inflammation, in order to preserve the life of the patient. Death of the tendons, necrosis of the bone, and stiffness of the joints are treated according to general rules. Sloughing portions of the tendons are removed with forceps and scissors. Necrotic phalanges are disarticulated under local anæsthesia. Stiffness of the fingers following extensive cellulitis is overcome, after the affection is cured, chiefly by baths, massage, and methodical movements. For the treatment of secondary conditions, particularly contractions of the fingers, see § 311, page 667 ff.

Acute inflammations of the finger joints are usually traumatic. Any wound involving a finger joint should be treated under strictly aseptic methods, and it is better to leave the superficial wound open. The injured joint should be immobilized by placing the hand upon a splint. If no suppuration ensues, complete return to the normal may follow. In case of suppurative inflammation of the joint, its mobility is only exceptionally preserved. Partial or complete ankylosis is more frequently observed. In suitable cases complete or partial resection of the suppurating joint is indicated. Care must always be taken that the suppurative process within the joint does not extend to the tendon sheaths. Compound fractures involving a joint are treated under anti-septic precautions and according to general rules. Any completely detached splinters are to be removed, and primary, partial, or complete resection of the joint may be necessary (see § 313, page 672). If a phalanx is torn off at the joint, enough of the projecting bone must be removed to enable the stump to be conveniently covered by soft parts.

Acute Inflammations of the Palm of the Hand.—The origin and the course of acute inflammations of the palm of the hand are essentially the same as those of inflammations of the fingers. Cellulitis of the palm is of the most interest. It sometimes arises primarily after an injury of this region and sometimes develops secondarily from the extension of a cellulitis of the fingers. Subcutaneous abscesses easily lead to deeper progressive suppuration. Superficial abscesses of the palm may also develop from blisters and calluses among labourers, oars-

men, etc. They are usually located in the region of the metacarpophalangeal joints. Cellulitis of the palm of the hand is always to be regarded as a serious affection, especially if the tendons are already surrounded by pus and if the synovial sacs and the joints are involved. As we have already stated, cellulitis of the hand frequently leads to serious destruction, especially of the tendons and the joints, with high fever, and the hand or the forearm must often be sacrificed in order to save the life of a patient. Even when there is a well-marked collection of pus deep down in the palm of the hand, fluctuation may be so indistinct, owing to the thickened skin of a labourer's hand, that an inexperienced physician waits too long before making the incision for which there is a pressing necessity.

The treatment of every acute inflammation, every case of cellulitis of the palm of the hand, consists in making an incision as early as possible in the longitudinal direction of the hand, which is to be as long and deep as necessary. In case of subfascial abscesses the skin is divided in a longitudinal direction and a dressing forceps or a closed artery clamp pushed into the abscess cavity. The location of the nerves and the palmar arch (see page 651) is always to be borne in mind. After free incision of the pus foci, and drainage and disinfection of the same, an antiseptic dressing is applied, the hand is placed on a splint, and the arm in a sling and given an elevated position. Regarding the termination of inflammations of the fingers and the hand, contractions, stiffness of the fingers, etc., see § 311, page 667 ff.

Diseases of the Nails, Onychia and Paronychia.—Inflammation of the nail or the matrix is called onychia, and inflammation of the soft parts surrounding the nail is called paronychia. The complete removal of the nail is necessary in case of suppurative inflammation of the matrix with a collection of pus under the nail and ulceration. The pointed blade of a pair of scissors is pushed down to the root of the nail, under local anæsthesia, the entire nail is divided longitudinally in the median line, and the halves are then completely extracted. The dressing is removed on the next day with the exception of the aseptic iodoform gauze which has dried upon the nail bed. A finger guard of soft leather is worn over this little aseptic crust until the latter falls off spontaneously or can be easily detached. The edge of the nail or the whole nail is also to be removed in case of acute or chronic suppurative paronychia.

Syphilitic inflammation of the matrix takes the form usually of an ulcerative process with the formation of fungous granulations. A circumscribed swelling first arises at the edges and the root of the nail which is attended with moderate pain. The nail then becomes more and more loosened, with ulceration of the matrix and the surrounding skin, and is either cast off as a whole or disappears more gradually. The new growth of the nail usually ensues in an imperfect manner. Moreover, every neglected case of non-

syphilitic suppurative onychia or paronychia may take a similar course, but, generally speaking, the destruction of tissue is more marked in syphilitic inflammation. There are usually other symptoms of syphilis, though the onychia and paronychia may be the result of a primary syphilitic infection, especially among physicians and midwives. The treatment of syphilitic onychia and paronychia consists in the removal of the nail, as described on page 660. The broken-down tissue is to be removed as far as possible, and dressings are then applied containing iodoform, bismuth, oxide of zinc, boracic ointment, etc. The syphilis itself is to be treated by inunctions, iodide of potassium, etc.

Characteristic changes in the form and color of the fingers and the nails are frequently observed in connection with diseases of the organs of respiration and circulation. The tips of the fingers become rounded in individuals suffering from phthisis, and the terminal phalanges enlarged and livid in those with cardiac disease. Disturbances of nutrition of the nails, with change in their structure and with deformity, are seen in connection with syphilis and gout, in the course of other chronic disturbances of nutrition, and after acute infectious diseases—typhoid fever, for example.

Onychogryposis and Onychomycosis.—By onychogryposis is understood a chronic inflammation of the matrix which leads to disturbances of nutrition and a peculiar hypertrophy of the nail, resulting in the formation of nails of great thickness or length, resembling claws (see also Surgery of the Foot). The nail proper—that is, its upper layers—is loosened more and more by the underlying newly formed masses of nail and displaced in the direction of the finger tip. This onychogryposis is sometimes conditioned upon disturbances of innervation and also upon parasitic causes.

Parasitic onychia or onychomycosis resulting from the growth of microbes in the matrix likewise leads to disturbances of nutrition of the nail, sometimes tending more to atrophy and sometimes more to hypertrophy of the latter. The atrophic, dry nails may fall off spontaneously, while the very thick clawlike nails present more the appearance of onychogryposis.

The treatment of onychogryposis and onychomycosis consists in removal of the nail and in the use of antiparasitic remedies (bismuth, oxide of zinc, iodoform, bichloride).

Skin Affections of the Hand and Fingers.—For the skin diseases proper of the fingers and the hand the reader must be referred to treatises upon dermatology. Only the following brief statement need be made here: The diseases of the skin that occur upon the hand are sometimes the local expression of a general disease, as, for instance, palmar psoriasis in connection with syphilis, and they are sometimes a purely local affection due to the patient's occupation. Among this latter variety of skin diseases eczema is especially to be mentioned—e. g., carbolic eczema and bichloride eczema on the hands of surgeons or patients, the eczema occurring among workers in paraffin in consequence of the action of the tar, among cloth-fullers, etc. The treatment of eczema consists in the removal of the existing cause and then in covering the skin with unguentum diachylon, and in the use of oxide of zinc and amyllum or preparations of tar.

The formation of calluses and blisters on the skin of the palm of the hand is frequently noticed among the labouring classes, also as the result of

rowing, exercising in the gymnasium, etc. We have already mentioned that deep abscesses of the palm of the hand in the region of the metacarpophalangeal joints sometimes follow such callosities and blisters.

Lupus sometimes appears on the hand and the fingers in a severe and extremely chronic form, which withstands vigorous treatment for years. Aside from ulcerative lupus, the epithelioma-like form with papillary pro-

liferations and elephantiasis-like thickening of the skin is also observed here. Serious destruction may ensue among adults from lupus of the skin. The treatment consists in a general strengthening regimen, in energetic local treatment by scraping with the sharp spoon, by the use of the thermo-cautery, or by excision of the diseased area. Recurrences are best prevented by skin-grafting.



FIG. 752.—Lupus hypertrophicus of the hand in a woman twenty-six years of age.

The so-called anatomical tubercle is a chronic form of infection from cadavers. It takes the form of moist, wartlike, and often ulcerating growths which are found especially upon the dorsum of the hand and upon the knuckles of anatomists and their assistants. Anatomical tubercle usually remains local. There sometimes ensue acute inflammatory symptoms, temporary acute lymphangitis and lymphadenitis, as well as abscess formation. Baumgarten, Karg, and others have demonstrated that in some cases anatomical tubercle is the result of infection by tubercle bacilli—i. e., that it is a form of local tuberculosis. Washing the hands in a solution of 1-to-1,000 bichloride and absolute alcohol, and wet dressings of the same, are especially to be recommended for the prevention of anatomical tuber-

cles and for the removal of such as already exist. In making autopsies, especially on infectious cadavers, smearing the hands with fat or vaseline and the use of India-rubber gloves are to be recommended. If a wound is received at an autopsy, it should be allowed to bleed for a time and then sucked out, and disinfected with alcohol, bichloride, or carbolic acid.

Elephantiasis of the Hand.—In consequence of chronic inflammations of the skin and the subcutaneous cellular tissue or after frequent attacks of erysipelas or lymphangitis, there occasionally ensues marked thickening of the skin with lymphangiectasis and hypertrophy of the hand, though the affection is by no means so frequent here as on the lower extremities. The treatment is directed, above all, against the existing cause. Dressings that exert pressure, massage, baths, and elevation of the hand are also serviceable. In severe cases improvement has been secured by ligation of the brachial artery.

Syphilis of the Hand.—We have already alluded to palmar psoriasis and syphilitic onychia and paronychia as local manifestations of constitutional syphilis. Primary syphilitic infection is occasionally observed on the hand and on the fingers (syphilitic dactylitis), especially among physicians and midwives; sometimes, in the beginning, as a scaly papu-

lar eruption; sometimes as a hard chancre, and again as a suspicious discoloured ulceration with severe inflammatory reaction, acute lymphangitis, and fever (syphilitic felon), so that the diagnosis is doubtful. Mixed infections also occur, complicated by sepsis or pyæmia. The above-described syphilitic onychia and paronychia are usually of a secondary nature, it is true, but they may be due to primary syphilitic infection. Midwives have repeatedly brought syphilis into families through syphilitic chancre of the fingers. Bardinet reports that thirty-one syphilitic infections could be traced to one midwife. Taylor observed a case of family syphilis where a midwife had infected the parents and four children.

The soft chancre also occurs on the fingers and the hand (see *Surgery of the Genito-urinary Organs*, § 228, page 377).

In every case of suspicious ulceration on the hand energetic therapeutic measures should be adopted. The best way is to destroy it as quickly as possible with the thermo-cautery.

In its later stages syphilis localizes itself not only, as has been already mentioned, in the skin, but also in the matrix of the nail and in the surrounding integument, especially as a gummatous infiltration of the soft parts and as gummatous periostitis and osteomyelitis. These gummatous processes in the soft parts and the bone—e. g., on the fingers (syphilitic dactylitis)—usually have a very protracted and a painless course. The enlargement of the fingers is sometimes marked, and the swelling may be hard or soft. In gummatous osteomyelitis and periostitis of the phalanges and the metacarpal bones the same “bottle-shaped” enlargement of the bones is seen as in tuberculosis (see Fig. 753). The gummatous infiltrations of the soft parts and the bones may gradually disappear in consequence of fatty degeneration, especially if a suitable constitutional treatment is begun, or they may break down and lead to fistulæ, caries, and necrosis of the bone, just as in tuberculosis. The joints are usually affected secondarily from the soft parts or the bones, but primary syphilitic inflammations of the joints also occur in rare cases (Surgis, K. Koch; see also *Principles of Surgery*, § 84, page 431, ff., and § 114, page 682).

The treatment is partly local, but chiefly constitutional (inunctions, iodide of potassium).

Tuberculosis of the Metacarpal Bone and Phalanges is observed especially among children. It usually begins primarily in the periosteum



FIG. 753.—Tubercular periostitis and osteomyelitis of the finger (“spina ventosa”).

or medulla, but may be secondary to tubercular disease of the soft parts—e. g., lupus of the skin or tubercular tenosynovitis. Tubercular periostitis and osteomyelitis are characterized by a “bottle-shaped” inflation of the fingers and the metacarpal bones (spina ventosa of the old surgeons, Fig. 753). Gummatous (syphilitic) periostitis and osteomyelitis also manifest themselves, as has been said, in the same way. The evidence afforded by the presence of tubercle bacilli, other constitutional symptoms, and an exact history of the patient decide whether the case is one of syphilis or tuberculosis. In tubercular periostitis and osteomyelitis of the fingers and the metacarpal bones the joints are at the outset uninvolved. The cortical substance becomes more and more thin, so that upon pressure a parchment-like crackling of the bone can be felt. In cases of long standing the caseous foci break through the bone and give rise to circumscribed abscesses, and the joints often finally become diseased secondarily. The fingers may be greatly deformed, and an entire phalanx may be destroyed by tubercular infiltration, or the growth of the finger stopped by destruction of the epiphyseal cartilage.

Treatment.—So long as there is no fluctuation nor formation of fistulæ, the process may be brought to a standstill by a general strengthening treatment (nourishing food, cod-liver oil, brine baths, sea baths, etc.). By way of local treatment injections of ten-per-cent iodoform-glycerin or iodoform oil into the inflated bone may be used. In case of abscesses and fistulæ, iodoform injections can likewise be tried, and, if necessary, thorough scraping with a sharp spoon. One should proceed in all this as conservatively as possible. Resection or extirpation of the diseased phalanx can not, however, always be avoided.

Chronic Inflammations of the Finger Joints.—Gout (arthritis urica) is not so common in the fingers as in the toes. The fingers may finally become very much deformed from frequent acute attacks, with swelling of the joints, and intra-articular and periarticular deposits of urates. We have already described the course and the treatment of gouty affections of the joints of the hand and the fingers (chiragra) on page 638.

The genuine arthritis deformans is to be distinguished from gout or its consequent conditions. The former is to be regarded essentially as a senile disturbance of nutrition of the finger joints, and it occasions increasing functional disturbance, partly in consequence of atrophy and partly in consequence of hypertrophy of the bones and cartilage, so that the involved fingers or the entire hand even may become more or less incapable of use. Traumatism is a frequent etiological factor, and women are affected much more frequently than men. Among thirty-four cases of polyarthritis deformans observed by Canton, there was but one male patient. All the others were women above forty years of age. The treatment of polyarthritis deformans consists chiefly in massage, methodical movements of the joints,

and the use of hydrotherapeutic methods, and the earlier these are undertaken the better. In the later stages a successful treatment of the trouble is usually hopeless. The use of iodide of potassium and salicylate of soda internally is serviceable.

Chronic serous inflammation of the finger joints is very rare. It is most frequently observed after sprains, and in case of free bodies in a joint, which are extremely rare. The effusion is made to disappear by massage and movements of the joint. Compression of the joint for a time by means of adhesive plaster and a small palmar splint of pasteboard or wood is also serviceable. Free bodies in a joint are removed by aseptic incision.

Tubercular inflammations of the finger joints are usually, as has been already mentioned, secondary to tubercular periostitis and osteomyelitis in the region of the epiphyses. The small joints are usually quickly destroyed by tubercular arthritis, and almost always become stiff. The treatment is the same as that of tuberculosis of the phalanges (page 664).

For the neuropathic diseases of the bones and joints occurring in syringomyelia, see *Principles of Surgery*, page 695.

Chronic Inflammations of the Tendon Sheaths of the Hand and Fingers may take the form of a serous, sero-fibrinous, suppurative, fungous, or gouty tenosynovitis.

Chronic serous and sero-fibrinous tenosynovitis occurs most frequently in the extensor tendons, and may be the result of gonorrhœal infection (Maymon, Lasèque, P. Vogt), just as in the tendons of the biceps and the brachialis anticus muscles, or of syphilitic infection in its first or later stages. In both cases an acute œdematous, fluctuating, painful swelling appears along the tendons, which then passes into the chronic stage and may last for weeks or months.

Chronic serous tenosynovitis of the tendons of the hand and the fingers also occurs in connection with lead poisoning and with gout. Gouty tenosynovitis gives rise to nodules, especially on the extensor tendons of the fingers, which may easily be mistaken for fibromata or chondromata.

Tubercular tenosynovitis is rare on the fingers and the hand. It gives rise to the same changes as in the tendons of the wrist and forearm (see § 303, page 630 ff.). Chronic inflammations of the tendon sheaths, with fistulæ, which occur after acute suppuration of the same and are conditioned mainly upon partial or complete death of the tendon at the place in question, should not be mistaken for tubercular tenosynovitis.

The treatment of the various forms of chronic inflammation of the tendon sheaths that have been mentioned varies according to the nature and cause of the affection. The reader is referred to what was stated regarding the same affections of the forearm and the carpus (see § 303, page 630 ff.).

We have already described ganglion on page 633. Verneuil, Foucher, Gillette, Witzel, Plenio, and others have called attention to the fact that the rare ganglia on the palm of the hand and on the flexor aspect of the fingers sometimes occasion neuralgia which radiates along the median and ulnar nerves, reaching even to the shoulder. In cases of long standing the nerves may become tender on pressure. These ganglia usually form small cysts under the tense skin of the palm of the hand at the base of a finger, and attached to the side of the tendon sheath, so that the neighbouring nerve is compressed. The reader is referred, for the origin, the symptomatology, and the treatment of ganglia, to page 633.

Idiopathic Gangrene of the Fingers is sometimes the result of a chronic obliterative endarteritis, and is sometimes conditioned upon primary disease of the nerves, especially the trophic and vasomotor nerves. This gangrene, resulting from disease of the nerves and tropho-neurotic disturbances, includes the so-called symmetrical gangrene of the fingers (Raynaud's disease), also the gangrene attending anæsthetic leprosy, and in part that attending scleroderma. The gangrene resulting from increasing local anæmia, in consequence of obliterative endarteritis, has essentially the same clinical course as senile gangrene of the toes. It is much less common on the fingers than on the toes.

The different varieties of idiopathic gangrene are described below :

1. The symmetrical gangrene of the fingers, which occurs especially among older women, is conditioned, according to Raynaud, upon a contraction of the vessels (*asphyxie locale*) proceeding from the vasomotor centre in the spinal cord. Raynaud distinguishes two forms of this local contraction of the vessels. In the mildest grade no gangrene occurs, and the fingers are only temporarily cold, pale, and without feeling, in consequence of the contraction of the arteries and veins. In the second form the contraction of the arteries and the congestion of the veins lead within months or years to ulceration or to circumscribed, non-progressive gangrene of a larger or smaller portion of the terminal phalanx, and always symmetrically on both hands. The treatment consists in improving the circulation in the fingers by means of warm baths, massage, inunction of alcohol, and the use of the constant current in a descending direction (one electrode on the spine, the other on the upper extremity). If already present, the gangrene is treated under antiseptic precautions and according to general rules.

2. Gangrene attending anæsthetic leprosy (see also Principles of Surgery, page 437). We have to do in this condition with a neuritis and perineuritis combined with sensory and trophic disturbances in the soft parts of the fingers, especially the skin. The anæsthetic parts undergo progressive gangrene, especially after injuries, and serious mutilations of the hand may ensue from the loss of the separate phalanges (Fig. 754). The disease is seen in Europe only among persons who have lived in regions where leprosy is endemic.

3. Gangrene resulting from scleroderma (whose etiology, as is well known, is still obscure) seldom occurs on the fingers, and only when the

scleroderma is complicated by trophic disturbances. We have to do in scleroderma with a peculiar hypertrophy of the cutaneous and subcutaneous connective tissue, so that the cutis becomes immovable on the subjacent parts and leatherlike in consistence. It has a very chronic course, although it may come to a standstill and improvement may ensue in parts. There may be complete restoration in places that were least affected. If gangrene is threatened or already exists—e. g., in consequence of constricting furrows—the latter must be overcome by means of multiple incisions.

4. The so-called spontaneous dactylolysis (Gruber, Menzel) is observed, as we saw on page 648, especially among persons with congenital abnormal depressions of the epithelium, particularly on the first phalanx. In consequence of the deepening of these epithelial furrows, the fingers may, in later years, gradually become amputated, much as in the analogous spontaneous amputation of the little toe in some negroes, which is called *ain-hum*. Multiple division of the constricting ring is the best treatment.

5. The rare form of gangrene resulting from poisoning by ergot is observed in epidemic ergotism as well as in sporadic ergot poisoning. Gangrene from ergotism is a result of vasomotor spasm of the vessels and the local anæmia caused thereby.

§ 311. **Contractions of the Fingers.**—We have already partially discussed contractions of the hand and the fingers in connection with the surgery of the forearm and the wrist, especially the ischæmic contractions and those resulting from injury and disease of the joints, nerves, tendons, and the other soft parts. There still remain the contractions of the fingers alone resulting from injuries and diseases of the hand and fingers. The same methods of treatment are applicable, generally speaking, in contractions of the fingers as in the similar contractions of the forearm (see § 291, page 593, ff., and Principles of Surgery § 119, page 706). In case of cicatricial contractions, division or excision of the cicatrices with subsequent skin-grafting is the best treatment.

Contractions of the fingers sometimes result from displacement of a tendon—e. g., flexion contractures may result from displacement of the ex-



FIG. 754.—Anæsthetic leprosy in a man forty years of age. All the terminal phalanges have disappeared, the second phalanx of the forefinger and middle finger is gone, while on the small finger and ring finger the second phalanx is necrotic and protrudes from the soft parts.

tensor tendon, which, as a consequence of this displacement to the ulnar side of the metacarpal bone, no longer acts as an extensor, but as a flexor. The displacement of the tendon is sometimes conditioned upon a loose condition of the paratendinous tissue in the vicinity of the first joint of the involved finger (H. Kruckenberg).

Dupuytren's Contraction (Fig. 755) is a very characteristic deformity of one or several fingers, most frequently of the last two, and is conditioned upon a thickening and shrinkage of the palmar fascia and its digital prolongations. This deformity is observed both among individuals who perform constant and heavy labour with the hands, and among those who do not have such hard work—e. g., among businessmen, clerks, and pianoforte-players. In the latter class of cases traumas are, to be sure, a frequent cause. I saw, as did P. Vogt also, Dupuytren's contraction in the case of a business-



FIG. 755.—Dupuytren's contraction.

man after an exhausting mountain tramp, occasioned by the unaccustomed pressure of an Alpenstock. In other cases there are gouty and other constitutional causes as well as hereditary conditions. The clinical picture of Dupuytren's contraction is very typical. The affection almost always begins on the ring or the little finger, and at the outset the involved fingers can not be fully ex-



FIG. 756.—Operation for Dupuytren's contraction.

tended. The flexion of the fingers then increases more and more in the course of years, till they finally lie firmly bent in the palm of the hand (Fig. 755). A firm fibrous band is usually to be felt in the latter, which is often as hard as cartilage. The tendons have nothing to do with the development of the contracture. They are perfectly intact. Gibney has described a congenital contracture of the hand which is similar to Dupuytren's contraction, but is said to be caused by atrophy and shrinkage of the skin. The hand is said to resemble the fin of a walrus.

The treatment of Dupuytren's contraction is operative. Busch's method consists in dissecting up from the indurated subjacent parts a triangular skin-flap, with its base toward the contracted fingers (Fig. 756), extirpating the contracted palmar fascia, and dividing the tense fibrous cords deep down until the finger can be completely extended.

The base of the skin-flap is united by a few sutures with the opposite edges of the wound, and the apex of the defect is allowed to granulate or is skin-grafted. The operation must be performed under strict aseptic methods. Of late I have not used Busch's method, but have extirpated the indurated subcutaneous tissue and divided the tense fibrous cords deeper down through a longitudinal incision. After straightening the fingers I suture the wound, with the exception of its posterior angle.

There is a peculiar form of contraction of the fingers known as "trigger finger." It occurs on all the fingers, but especially on the thumb, the middle and the ring fingers. Its characteristic is that flexion and extension of the fingers, which otherwise appear normal, can be only imperfectly executed. Up to a certain point the flexion is free, but further flexion is possible only with the aid of the other hand, or—and that is the characteristic of the affection—the finger snaps at a certain degree of flexion into complete flexion, like the blade of a pocket knife, often with a crackling sound, attended with pain. The same thing occurs when the finger is extended. It is as if the gliding of the tendon were hindered at a particular place.

The real cause of trigger finger is probably a disproportion between the size of the tendon and the volume of its sheath at a particular point (Hyrtil, Notta, Menzel)—i. e., there is a circumscribed thickening of the tendon or narrowing of its sheath, in consequence of inflammation or an injury, or there is a free body in the tendon sheath, etc. The movement of the finger is free up to the narrowed passage, and the obstacle is then overcome only by the exertion of greater force. At the moment the tendon has passed through the contracted part the finger springs into complete flexion or extension.

Treatment.—If massage and methodical movements do not effect a cure, exposure of the involved part of the tendon by an incision is to be recommended, especially in case of a thickening that can be felt or free bodies in the tendon sheath. After the sheath has been opened, one proceeds according to what is found and removes the existing mechanical obstacle or overcomes the disproportion between the tendon and its sheath.

Professional Spasms.—Certain occupations give rise in some cases to a spastic neurosis of the hand. The affection is designated, according to the occupation of the individual patient, writer's palsy, piano-player's cramp, shoulder cramp, seamstress's cramp, telegrapher's cramp, etc. Writer's cramp is the most common form. The harmony of movement of the muscles of the hand and fingers which are used in the patient's special occupation—that is, for example, for holding the pen in writing, for playing the pianoforte, etc.—is disturbed, and these movements can not be executed at will. The affection usually begins with overtiring of particular muscles of the forearm and the hand, in consequence of their overexertion. Two forms of cramp can be distinguished, the spastic and the paralytic. In the spastic form fatigue and

trembling of the hand and the fingers are observed at first, and then, finally, the characteristic cramp, mostly of the flexors, so that the hand becomes useless for writing, playing the pianoforte, etc. In the paralytic form the patient can execute no definite movement, the pen, for instance, falling from the hand. In severe cases spasm of the fingers ensues when the patient merely thinks of the execution of certain movements.

The causes of this affection are not always of a peripheral nature. It is sometimes due to central disturbances, and in this case there are usually other neuro-pathological symptoms also—e. g., tremor, stuttering, chorea, areas of hyperæsthesia, painful places along the cervical portion of the spine, etc.

The treatment of the various forms of spasm or palsy of the fingers which have been mentioned as existing among writers, piano-players, etc., is essentially of a local character. It consists, above all, in massage, electricity, douches, and baths. The use of the hand for the special occupation in question is to be restricted. In case of writer's palsy the use of properly constructed penholders, of which there is a great variety, is to be recommended. A general strengthening treatment is of great importance (sea baths, mountain resorts, life in a southern climate). Many persons without a medical education (masseurs) make a specialty of treating writer's cramp and render excellent service. In case of a central cause, and in case other neuro-pathological symptoms exist, the treatment should also be directed against these.

§ 312. **Tumours of the Hand and the Fingers.**—Warts are the most common affection under this head. They sometimes occur in large numbers, especially on the back of the hand and fingers. The development of warts often has a connection with injuries. They frequently disappear spontaneously, and thus is to be explained the much-lauded efficacy of peculiar remedies and sympathetic cures. Warts are best removed as follows: The uppermost layer of the wart is removed painlessly with a knife without causing it to bleed, and chromic acid is then applied (one part to three of water), or arsenical paste, for an hour or two. The cauterization with arsenical paste usually has to be repeated several times. I use the arsenic-morphium paste as applied by dentists for the cauterization of the pulp cavity (killing the nerve, as it is called).

The so-called epithelial cysts are sometimes observed on the fingers, which resemble dermoids and sebaceous cysts and result from the implantation of epidermal cells in consequence of traumatisms. They are often mistaken for ganglia. These cysts consist of a dense fibrous sac, in which, as the result of proliferation of the implanted epithelium, epithelial pearls are found, or in larger cysts an atheromatous material. Labouyle, who has collected forty-two cases of such epithelial or epidermal cysts, believes that they sometimes

develop from strayed groups of cells—e. g., in connection with the formation of the interdigital furrows. The treatment consists in excision of the small tumours, which are sometimes fluctuating and sometimes tense.

Of other epithelial tumours, one finds occasionally cutaneous horns and epitheliomata. The latter are rare, but occur sometimes among workers in paraffin (see Fig. 732).

Of the non-epithelial tumours, I mention first the angeiomata and cavernous tumours, which occur sometimes in the skin, sometimes in the subcutaneous adipose tissue, and which, in the latter case, are often cavernous lipomata. The angeiomata and cavernomata sometimes form circumscribed tumours and sometimes a diffuse elephantiasis-like hypertrophy, which extends over the hand and the forearm. Regarding the occurrence of arterio-venous aneurisms with multiple angeiomata, or aneurisms and varices, the reader is referred to the case represented in Fig. 716, page 609. Circumscribed angeiomata and cavernomata are treated by excision. In case of more extensive diffuse formations, the use of the thermo-cautery is to be recommended, and, in case of dif-

fuse arteriovenous aneurisms, early ligation of the involved arterial trunk. In some cases the primary aneurismal sac is divided or excised after proximal and distal ligation of the same. If in the advanced stages—for instance, of an arteriovenous aneurism—there exist numerous aneurisms and dilatations of the veins, a cure by ligation of the main vessel or by compression is very uncertain, and the disturbances may be such that amputation is desired by the patient, as, for example, in the case represented in Fig. 716, page 609.

Lipomata are observed on the hand, particularly on the palm and the thenar eminence. Diffuse lipomata occur especially along the course of the tendon sheaths (Ranke, J. Grosch, the author). A circumscribed lipoma of the hand is easily mistaken for a hygroma of a tendon sheath.

Fibromata and neuromata of the hand are rare. A fibroma of the tendon sheath may bear close resemblance to a ganglion. Keloids may also be mentioned here, which have sometimes been observed on the hand and may lead to extreme cicatricial contraction of the fingers (see Fig. 757).

Enchondromata occur rather frequently on the fingers. They originate in the periosteum or medulla, and form very characteristic nodular tumours, which are often multiple (Fig. 758). A traumatism is frequently the cause. The periosteal enchondromata can be enucleated with preservation of the continuity of the bone, or removed from the bone by means of the chisel or



FIG. 758.—Enchondroma of the left hand in a woman twenty years of age (Leo).



FIG. 757.—Keloid of the fingers (Volkmann).

the saw. In case of medullary chondromata also amputation or disarticulation of the involved phalanx or of the finger is but seldom indicated. They also can usually be enucleated with preservation of the bone, or scraped out with a sharp spoon. If necessary, the phalanx may be resected with preservation of the periosteum.

Osteomata and exostoses occur especially on the terminal phalanx under the nail, but are not so frequent here as on the great toe.

Among malignant connective-tissue tumours of the hand and the fingers, the very rapidly growing medullary osteo-sarcomata, the melanotic sarcomata, and the non-malignant fibro-sarcomata of the periosteum and the tendon sheaths are especially to be mentioned. The sarcomata of the finger-tip, situated beneath the nail, are also, as a rule, non-malignant, so that the finger can usually be preserved.

All malignant tumours of the hand and fingers (sarcoma and carcinoma) should, of course, be removed through sound tissue, but one should preserve all that can possibly be left. A stump which, for example, possesses a normally movable thumb is far preferable to an artificial amputation stump.

§ 313. **Operations on the Hand and Fingers.**—For the resection of a metacarpo-phalangeal joint or an interphalangeal joint, a lateral inci-

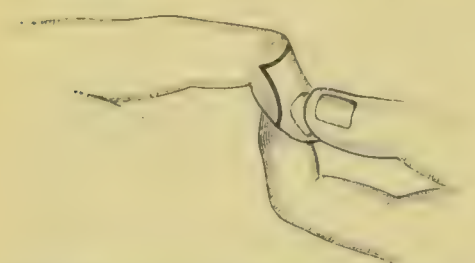


FIG. 759.—Disarticulation of the terminal phalanx by means of a palmar flap.

sion two to three centimetres in length is made alongside the extensor tendon and down to the bone. The incision must not be made too near the palmar surface, for fear of wounding the digital nerve and artery. After opening the joint, the capsule, the periosteum, and the flexor and extensor tendons are pushed to one side, and the isolated ends of the bone

scraped out or cut off with a Liston or Luer bone-cutting forceps, or sawn off to avoid splintering. If one of the joint surfaces is intact, it is of course left.

Amputation of the Fingers is to be preferred, in suitable cases, to their disarticulation, as one always strives to retain as much bone as possible. Too short stumps of the first phalanx only are more detrimental than useful. Amputation of the fingers is best performed by the circular method, or one may make an anterior overhanging flap or an anterior and posterior flap—e. g., by a circular incision with two lateral ones. It is better to saw the bone, because, as has been said, splintering is likely to occur when the phalanx is cut off with bone forceps.

Disarticulation of the Middle and the Terminal Phalanx.—Disarticulation of the fingers can usually be performed under local anæsthesia (cocaine, ether spray), or ethyl bromide may be employed. In disarticulation of a terminal phalanx the operator grasps the phalanx as

shown in Fig. 759, and makes a transverse incision just below the head of the second phalanx on the extensor side, extending into the joint. After the two lateral ligaments have been severed with a pointed knife, the latter is passed behind the palmar surface of the terminal phalanx with its edge directed downward, and a palmar flap is cut with sawing strokes. The severed tendons retract, or, if necessary, must be shortened somewhat. Then follow ligation or torsion of the digital arteries and suture. Lateral flaps or a dorsal flap may be employed if the conditions require it.

Disarticulation of the middle phalanx is performed in precisely the same way.

Disarticulation of the Fingers at the Metacarpophalangeal Joint is usually performed by the racquet-shaped incision (Fig. 760, *a*). The apex of the incision lies above the head of the metacarpal bone and the base on the palmar surface of the root of the finger. After making the incision

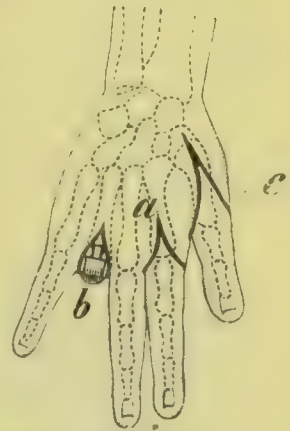


FIG. 760.—Disarticulation at the metacarpophalangeal joint by means of a racquet-shaped incision.

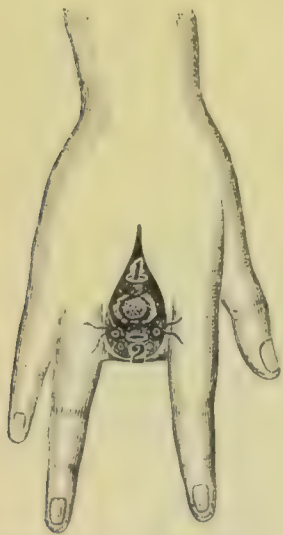


FIG. 761.—Disarticulation of the middle finger: 1, extensor tendon; 2, flexor tendon with the two digital arteries and nerves, and in the middle of the wound the head of the metacarpal bone.

in the skin the soft parts are divided down to the bone. To make sure that the flap is not too small, the two lateral incisions must not pass through the commissures of the fingers, but be carried farther down on the sides of the first phalanx. The lateral ligaments, the tendons, and the capsule are then divided by drawing the finger first in one direction and then in the other. The wound has finally the form represented in Fig. 760, *b*, and Fig. 761. The two digital arteries at the base of the flap are either tied or twisted, and the wound closed by suture in a longitudinal direction. If the flap should prove to be too short, the head of the metacarpal bone may be removed.



FIG. 762.—Disarticulation of two fingers.

Lateral flaps can be used on the thumb, the index finger, and the little finger, which are more accessible than the other fingers, from the side. An oval skin-flap is dissected up from the palmar, the dorsal, or the lateral aspect of the first phalanx, and a shorter flap is cut on the opposite side. The flaps are reflected and the lateral ligaments, the

tendons, and the capsule are severed. The disarticulation of two adjoining fingers can be performed as shown in Fig. 762.

Disarticulation of the Thumb at the Metacarpo-carpal Joint.—There are two methods in use here—one with a racquet-shaped incision, and the lateral-flap method.

1. The racquet-shaped incision (Fig. 760, *c*, and 763) may be started either at its base, on a level with the web on the flexor side of the



FIG. 763.—Disarticulation of the thumb at the metacarpo-carpal joint.

metacarpo-phalangeal joint of the thumb, or at its apex. In the latter case the incision begins in the region of the articulation between the trapezium and the metacarpal bone of the thumb, passes along the dorsal aspect of the metacarpal bone and then

around the base of the first phalanx in a radial and ulnar direction near the metacarpo-phalangeal joint, always cutting down to the bone. The metacarpal bone is then detached subperiosteally, if possible, from the soft parts along the course of this incision. The joint between the trapezium and the metacarpal bone is opened from the ulnar side, and in doing this the knife must be kept close to the base of the latter, so as not to open the joint between the trapezium and the metacarpal bone of the index finger, which forms, as is well known, a part of the common metacarpo-carpal joint and also communicates indirectly with the midcarpal joint. The articular ligaments and the capsule of the carpo-metacarpal joint of the thumb are then severed on all sides and the disarticulation completed.

2. The lateral-flap method is by no means so good as the above. The thumb is abducted and the middle of the web between the thumb and the index finger is divided with sawing strokes, as well as the remaining soft parts between the first and second metacarpal bones, until the base of the first metacarpal bone is reached (Fig. 764). The edge of the knife is carefully passed under the base of the metacarpal bone of the thumb, and the joint is opened, whereby the joint between the trapezium and the metacarpal bone of the index finger must be avoided. After disarticulation of the metacarpal bone the thumb is still more strongly abducted, and by carrying the knife along the radial side of the meta-

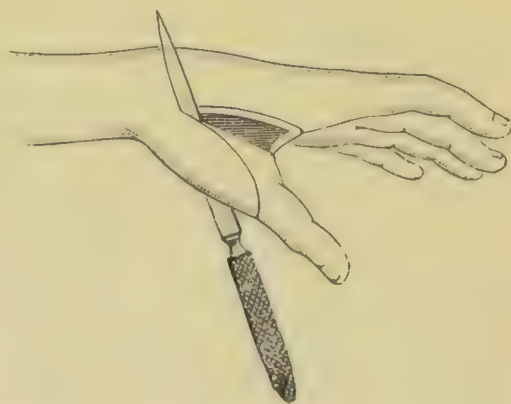


FIG. 764.—Disarticulation of the thumb at the metacarpo-carpal joint with the formation of a lateral flap.

carpal bone of the thumb, a rather long radial flap is cut with a rounded apex (Fig. 764).

For transforming a thumbless hand into one capable of grasping objects and thus increasing its usefulness, Lauenstein recommends sawing through the middle of the metacarpal bones of the index and little fingers, bringing the two fingers into opposition to the middle and ring fingers by turning them toward the palmar surface, and letting them unite in this position.

Disarticulation of the little finger with the metacarpal bone at the carpo-metacarpal joint is performed in precisely the same manner as that of the thumb.

Disarticulation of the remaining fingers with their metacarpal bones is likewise accomplished by means of the racquet-shaped incision. If it is desired to remove two adjacent metacarpal bones with the fingers belonging to them, the simplest way is to make a longitudinal dorsal incision between the two metacarpal bones and transverse incisions to each side at both ends of the first incision. After dissecting up both rectangu-



FIG. 765.—Amputation at the middle of the hand with preservation of the thumb.



FIG. 766.—Amputation or disarticulation of the last four metacarpal bones with preservation of the first. Palmar incision.



1



2

FIG. 767.—Amputation or disarticulation of the last four metacarpal bones with preservation of the first. Dorsal incision: *a*, carpo-metacarpal joint; *2*, appearance of the wound after insertion of the sutures.

lar flaps, the two metacarpal bones with the fingers belonging to them are disarticulated.

Removal of the Metacarpus with the Exception of the Thumb, either by amputation of the last four metacarpal bones or by their disarticulation at the carpo-metacarpal joints, is a very useful operation, as the preservation of the thumb proves extremely advantageous. If

possible, one will choose amputation of the last four metacarpal bones rather than their disarticulation at the carpo-metacarpal joint, because in the latter operation the mid-carpal joint is also opened and the carpal joint of the thumb can easily be injured. The operation is performed, according to Fig. 765, by making a palmar flap, or, better, in the following manner as shown in Figs. 766 and 767: A semilunar flap of soft parts is formed from about half the palm of the hand, which is dissected up from the bone. The palmar incision begins at the web of the thumb and ends on the ulnar border of the base of the fifth metacarpal bone (Fig. 766). The soft parts of the dorsum of the hand are either divided by a semicircular incision or by the incision shown in Fig. 767, 1. The latter incision, which is especially adapted to the disarticulation of the last four metacarpal bones, begins at the web of the thumb, runs obliquely upward to the upper third of the second metacarpal bone, and then obliquely over the last three metacarpal bones and into the end of the palmar incision. After dissecting back the flaps that have been described, the last four metacarpal bones are sawn through or disarticulated from the ulnar side at the carpo-metacarpal joints. Injury to the joint between the metacarpal bone of the thumb and the trapezium is carefully to be avoided when the articulation between the second metacarpal bone and the trapezium is opened.

For the technique of bandaging the hand and the fingers, see Principles of Surgery, §§ 50-55.

SEVENTH SECTION.

SURGERY OF THE LOWER EXTREMITY.

CHAPTER XXXIII.

INJURIES AND DISEASES OF THE HIP JOINT AND THE THIGH.

Anatomy of the hip joint.—Traumatic dislocations of the hip.—Congenital and pathological dislocations.—Fractures of the acetabulum (see § 259, page 476 ff.).—Fractures of the upper end of the femur: Fractures of the head, neck, epiphysis, and greater trochanter.—Gunshot wounds of the hip joint.—Rhachitic curvatures of the neck of the femur during the period of growth.—Unequal length of the legs in normal individuals.—Inflammations of the hip joint.—Tubercular coxitis in children.—Other inflammations of the hip joint.—Suppurative inflammation.—Serous effusion.—Nervous (hysterical) coxitis.—Arthritis deformans (malum senile).—Contracture and ankylosis of the hip joint.—Subtrochanteric osteotomy.—Resection of the femur for ankylosis.

Injuries of the soft parts of the thigh.—Ligation of the femoral artery and vein.—Muscular herniæ.—Rupture of the quadriceps muscle and of the ligamentum patellæ.—Fracture of the shaft of the femur.—Linear and cuneiform osteotomy of the femur.—Inflammatory processes of the thigh.—Cellulitis.—Bubo.—Psoas abscess.—Sciatica.—Subcutaneous and open stretching of the sciatic nerve.—Aneurisms.—Varicose veins.—Lymphangiectasis, elephantiasis.—Hygroma of the iliac bursa and other bursæ.—Diseases of the femur.—Sequestrotomy of the femur.—Tumours of the thigh.

Resection of the hip.—Amputation at the hip.—Amputation of the femur.—For the technique of bandaging the hip and the thigh, see Principles of Surgery, §§ 50–55.

§ 314. **Anatomy of the Hip Joint.**—The hip joint, like the shoulder, is an enarthrodial or a ball-and-socket joint with free movements in all directions. The edge of the acetabulum is provided with a fibrous rim (cotyloid ligament), by which the joint cavity is correspondingly deepened. The portion of the cotyloid ligament which bridges over the notch of the acetabulum is called the transverse ligament. In the bottom of the acetabulum, the so-called fossa acetabuli, there is found a mass of fat. The capsule is united with the head of the bone by the ligamentum teres, which is neither round nor a ligament, but a synovial fold, which has a part in the formation of the synovial fluid, enters the articular cavity through the cotyloid notch under the transverse ligament, and is inserted into a depression in the head of the femur. The arteries of the ligamentum teres do not enter the head of the

femur, but form loops and pass back into veins (Hyrthl). The strength of the ligamentum teres is very variable. In very rare cases it is wanting altogether, but without appreciable disturbance of the normal movement of the joint, much as after dislocations with rupture of this ligament. The capsule arises partly from the outer surface of the acetabulum, partly from the cotyloid ligament, and is attached in front to the anterior intertrochanteric line,



FIG. 768.—*a*, Ilio-femoral ligament.

and leaving this line at the base of the lesser and the great trochanter, is inserted posteriorly above and parallel to the posterior intertrochanteric line. It follows from this that the anterior surface of the neck of the femur is wholly intra-articular, while its posterior surface is so for the most part. The innermost synovial layer of the capsule covers the part of the neck of the femur that is intra-articular and ends about at the border of the cartilaginous covering of the head. The capsule is supported partly by circular and partly by firm longitudinal bands or ligaments. Of the latter the most important are the ischio-capsular ligament arising from the ischium, and above all the strong ilio-femoral ligament (Fig. 768, *a*), which arises from the anterior superior spine of the ilium, passes down in intimate connection with the capsule, and divides into two parts. The outer band is inserted at the upper end of the anterior intertrochanteric line and on the

great trochanter, and the inner band at the base of the lesser trochanter. Hence the name Y-shaped ligament (Fig. 768). This ilio-femoral ligament is, as we shall see, of the greatest importance for the mechanism of dislocations. It is scarcely ever completely ruptured in these injuries, but usually tears off a portion of the cortical layer of the femur. Finally, the ligamentous fibres which arise from the os pubis (pubo-femoral ligament) are also of importance in strengthening the capsule. The capsular ligament is weakest at its inner and lower portion.

Of the bursæ in the vicinity of the hip joint, that of the ilio-psoas muscle, the iliac bursa, is of special practical importance. It communicates with the hip joint and, like the subscapular bursa of the shoulder, is to be regarded as a reservoir for the synovial fluid of the joint.

Movements of the hip joint are possible about all conceivable axes passing through the centre of the head of the bone, especially (1) flexion and extension, (2) abduction and adduction, and (3) external and internal rotation. The range of motion of the hip joint has been carefully measured, especially by the Weber brothers, and also by Henke. According to the measurements of the Weber brothers, the arc of flexion and extension amounts on the cadaver to 139° and on the living body to only 86°, abduction and adduction to 90°, and rotation to 59°. Henke found the range of movement somewhat greater.

The limits to the movements of the hip joint are of special importance for the occurrence of dislocations. The ligamentum teres, according to Henle and others, does not check these movements. Extension is checked

chiefly by the ilio-femoral ligament, flexion by the contact of the soft parts of the thigh with the soft parts of the abdomen, and in the case of very thin persons by the impact of the neck of the femur against the upper rim of the acetabulum. Abduction, adduction, and rotation are arrested by the ilio-femoral ligament. If the ilio-femoral ligament is relaxed—e. g., in a flexed position of the hip—freer abduction, adduction, and rotation are possible.

The head and the acetabulum are kept in permanent contact by the pressure of the atmospheric air (Weber brothers).

The pathological mechanism of the hip joint is of great practical importance with reference to apparent shortening and lengthening of the leg, as well as for compensation in case of contractures. Flexion contractures of the hip joint are compensated for by a corresponding inclination of the pelvis and lordosis of the lumbar segment of the spine when the patient tries to place his leg which is flexed at the hip on the floor beside the well one. If, on the other hand, an abduction contracture of the hip joint exists, the patient lowers that half of the pelvis, in order to bring his leg into a perpendicular position. The sound leg is abducted somewhat. The diseased leg, with its abduction contracture, seems lengthened in consequence of the lowering of the pelvis on that side. The spine is bent laterally (scoliosis) in consequence of the lowering of the pelvis on one side, in order that the centre of gravity of the body may not be displaced and the patient may not fall over to one side in consequence. In case of an adduction contracture the relations are reversed. The patient then elevates the half of the pelvis on the diseased side and abducts the sound leg. The diseased, adducted leg is apparently shortened. The lumbar segment of the spine curves correspondingly toward the sound side and the cervical segment toward the diseased side (so-called static scoliosis). All these facts are of the greatest importance for the understanding of hip-joint disease.

§ 315. **Traumatic Dislocations of the Hip.**—Dislocations of the hip are of rather infrequent occurrence, and the action of considerable violence is required to displace the head of the bone from the deep acetabulum and to rupture the stout capsule with its above-mentioned accessory ligaments. Of all dislocations, about fifty-eight per cent are those of the shoulder and only two per cent those of the hip (Krönlein). The dislocations of the hip are most frequent among men of the labouring classes from about thirty to fifty years of age. In earlier and later life fractures of the neck of the femur are much more common than dislocations. The latter, therefore, scarcely occur among children and old people. Dislocations of the hip, like all traumatic dislocations, arise from overstepping of the physiological range of flexion, extension, abduction, adduction, or rotation. After rupture of the ligamentum teres the head is forced out of the socket, and is then, chiefly through secondary movements, brought into a definite location in the vicinity of the acetabulum. This location depends upon the nature of the violence that acts or of the movement of the joint that

takes place, and depends also very largely upon whether or not the stout ilio-femoral ligament remains intact or not. If the latter is com-

pletely ruptured at its point of insertion on the femur or in its continuity, Bigelow calls the dislocation "irregular." In Bigelow's regular dislocation the ilio-femoral ligament is intact or only its outer band ruptured.

After the reduction of an uncomplicated dislocation of the hip the function of the joint is usually restored in a satisfactory manner. If, on the other hand, reduction does not take place, the head of the bone forms for itself a more or less complete new joint (Fig. 769). The old socket becomes more and more obliterated.

We distinguish, according to the location of the head of the bone, the following chief forms of dislocation of the hip:

1. Dislocation backward. The head rests either on the ilium (iliac dislocation) or in the ischiatic notch (ischiatic dislocation). Dislocation backward arises usually from flexion, with abduction or adduction and rotation of the thigh.
2. Dislocation forward. The head rests on or under the os pubis, and hence the two varieties: *a*, suprapubic dislocation, with the three subdivisions, pubic, ilio-pectineal, and intrapelvic dislocations (Scriba); *b*, infrapubic dislocation, with the two subdivisions, obturator and perineal dislocations. These dislocations arise usually from overextension, likewise with abduction or adduction and rotation, but sometimes from flexion.

3. Dislocation upward (supraglenoid dislocation).

4. Dislocation downward (infraglenoid dislocation).

According to Holmes Coote, dislocation of the femur upon the obturator foramen is the most frequent primary form, in consequence of the comparative weakness of the capsule at this point, and then from this position, in consequence of the secondary movement of the head of the femur, the head assumes a different location, according as the ilio-femoral ligament is intact or not. Dislocations backward are



FIG. 769.—Old supracotyloid dislocation of the femur with a newly formed acetabulum (Krönlein).

the most common. According to F. Kneer, of 210 dislocations, 160, or 76 per cent, were backward. According to Astley Cooper, of 292 cases, 53·1 per cent were iliac, 24·3 per cent ischiatic, 14 per cent infrapubic, and 8·6 per cent suprapubic dislocations. Dislocations directly upward or downward are extremely rare.

I. Backward Dislocations.—In backward dislocation of the head of the femur the latter comes to lie either behind and above upon the ilium (iliac dislocation), or behind and below upon the ischium or the ischiatic notch (ischiatic dislocation). Backward dislocations arise most frequently from flexion, adduction, and inward rotation of the thigh

—e. g., from a fall from a considerable height, from being buried up, from injury by machinery, etc. The head of the femur is forced against the posterior lower wall of the capsule and pried out of the socket, so that it rests upon the posterior lower rim of the acetabulum. The capsule is

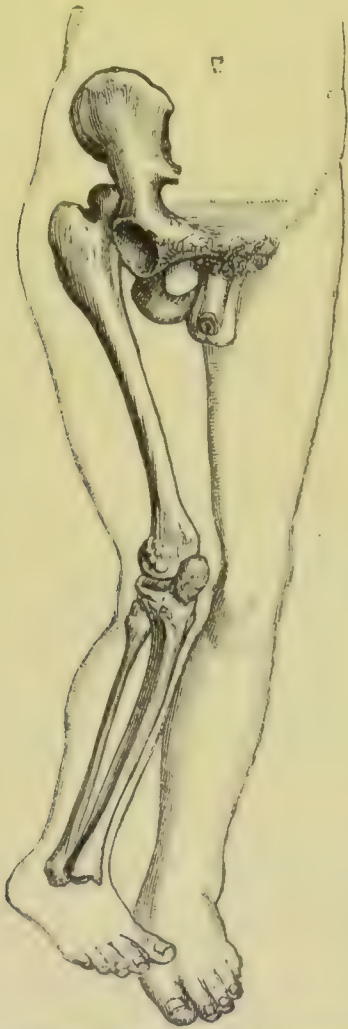


FIG. 770.—Backward dislocation of the hip.

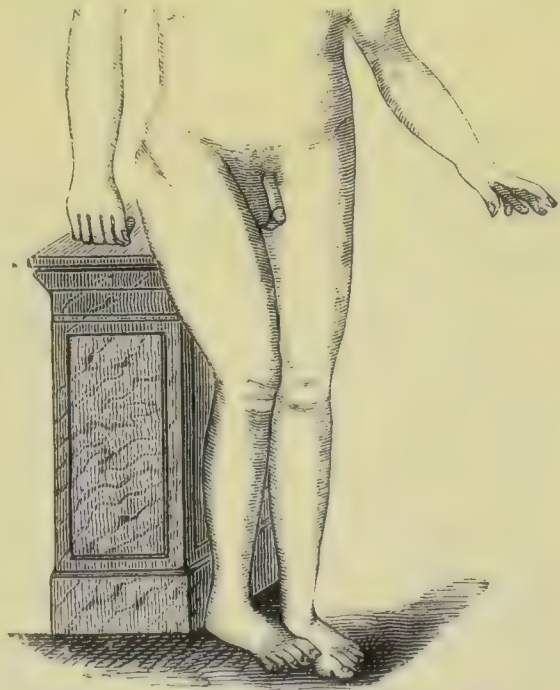


FIG. 771.—Position of the leg in backward dislocation of the hip.

usually ruptured in its posterior lower part below the tendon of the obturator internus muscle. The dislocated head of the bone usually slips backward and downward upon the ischiatic notch below the tendon of the obturator internus muscle, and either remains here permanently (ischiatic dislocation), or, more frequently, an iliac dislocation arises from the primary ischiatic dislocation by secondary upward movement of the head and by more or less inward rotation—that is, the

head comes to lie above the tendon of the obturator internus on the ilium (Fig. 770). A direct iliac dislocation with rupture of the capsule above the tendons of the obturator internus and externus muscles is less frequent. Generally speaking, the more the leg is flexed at the moment of the occurrence of the dislocation, the lower the final position of the head of the femur. The head is fixed in its abnormal place by the usually intact ilio-femoral ligament and the parts of the capsule that are preserved, and prevented from further upward displacement. The ligamentum teres is always, no doubt, ruptured, and usually at its insertion on the head of the femur.

Of other injuries in connection with backward dislocation of the femur, the following are especially to be noticed: Laceration and detachment of the cotyloid ligament, stretching and contusion of the sciatic nerve by the neck of the femur, compression or rupture of the gluteal vessels, stretching and partial lacerations of the muscles which are inserted on the front of the femur (pectineus, ilio-psoas, abductors), sometimes also fracture of the rim of the acetabulum, stellate fracture of the floor of the latter, fracture of the head of the femur by traction of the ligamentum teres (H. Braun), and fracture of the neck of the femur or its shaft.

The symptoms of backward dislocation of the femur are very characteristic (Figs. 770, 771). The dislocated leg is slightly flexed at the hip, and the knee rotated inward, adducted, and shortened. The top of the great trochanter, which is turned forward and inward, does not lie in its normal place in the so-called Nélaton's line, but from two to five centimetres above it. Nélaton's line is of the greatest importance for the diagnosis of all injuries and diseases of the hip. It runs from the anterior superior spine of the ilium over the top of the great trochanter to the tuberosity of the ischium. In the iliac dislocation the trochanter lies higher above Nélaton's line than in the ischiatic dislocation, and the leg therefore seems more shortened in the former. The firm resistance in front, caused normally by the head and neck of the femur, is absent, and in its place a depression is felt. The gluteal region is fuller, the gluteal fold is elevated, and the dislocated head of the bone can be felt through the gluteal muscles, especially when the thigh is rotated and flexed. The active movement of the hip joint is suspended, and the leg is fixed in its abnormal position. On attempting passive movements it is found that the leg is capable of further flexion, but this is very slight and attended by severe pain, and it can be adducted and rotated inward. Patients often complain of great pain and a feeling of numbness reaching to the foot, as a result of compression of the sciatic nerve. There is sometimes retention of urine

in consequence of the shock, or on account of the concussion or injury of the pelvic viscera.

The typical group of symptoms which has just been given is somewhat changed in the so-called "irregular" backward dislocations (Bigelow)—that is, when, in rare and exceptional cases, the ilio-femoral ligament is completely ruptured. The dislocated leg may then simply be everted, following its weight, and be passively more movable. The dislocated caput femoris which rests upon the ilium may be turned forward (Monteggia).

The diagnosis of a backward dislocation of the head of the femur upon the ilium or into the ischiatic notch is not difficult. The characteristic deformity, the depression at the site of the articular cavity, the fact that the head of the bone can be felt behind, the fixation of the joint, are all that is needed to distinguish dislocation from fracture of the neck of the femur, and especially from an impacted fracture of the same. A dislocation is also scarcely to be confounded with a contusion of the hip attended by a marked extravasation of blood. Examination of the patient under an anæsthetic will afford the surest evidence as to any complications. In case of ischiatic dislocation a rectal examination is to be recommended. A special indication of fracture of the rim of the acetabulum is the circumstance that the dislocation easily recurs after reduction. In case of simultaneous fracture of the neck of the femur, or in case of rupture of the ilio-femoral ligament, the leg is not adducted and rotated inward, but everted from its own weight.

The prognosis of backward dislocation of the hip is favourable in cases that are free from complications. If reduction is made immediately after the occurrence of the dislocation, the use of the leg is usually well restored. The prognosis is very essentially affected by simultaneous fractures of the acetabulum or the neck of the femur, as well as by extensive injury to the soft parts. The very rare compound dislocations of the hip are always to be looked upon as severe injuries, after which permanent functional disturbances usually remain. In old cases reduction is difficult, and it may be impossible even after a few weeks. Cases have been known, however, in which after a year manual reduction of the dislocation has proved successful (Hueter). In case of old, unreduced dislocations there is formed, to be sure, a new articulation at the abnormal place with increasing obliteration of the old socket (nearthrosis, see page 680, Fig. 769), but the patient can walk only with the aid of crutches, as a rule, and the shortened, atrophic leg is slightly flexed and adducted. There are, however, exceptions to this rule, and strikingly slight impairment in the ability to walk is sometimes observed.

Treatment of Backward Dislocations.—Reduction may be rendered difficult or impossible, especially by the location and the nature of the rent in the capsule—e. g., by a transverse rent (Gellé), also by the ilio-femoral ligament, and the interposition of broken-off fragments of bone between the head and the acetabulum.

Reduction is performed as follows: In order to overcome the resistance of the soft parts, especially that of the muscles, it is always best

to anaesthetize the patient. He lies upon a mattress on the floor, and an assistant fixes the pelvis by laying his hands upon the two anterior superior spines. All violence is to be avoided in performing reduction. Even the best surgeons have had the misfortune to produce a fracture of the neck of the femur. The leg, which is flexed at the knee and the hip, is grasped



FIG. 772.—Reduction of an iliac or ischiatic dislocation of the hip by flexion, abduction, and outward rotation.

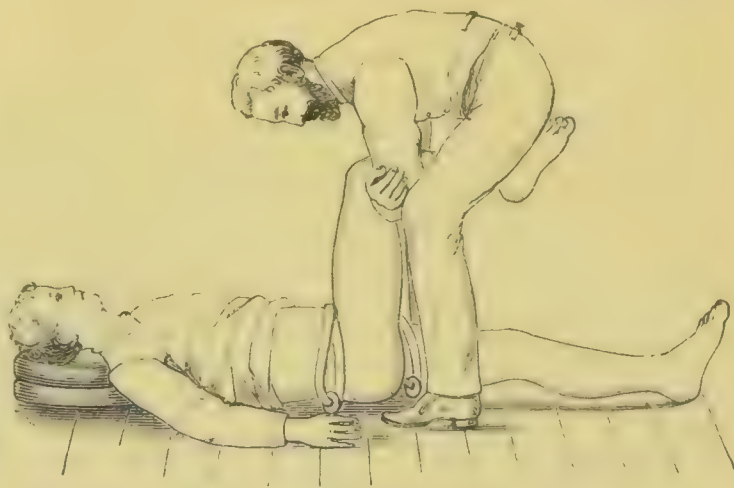


FIG. 773.—Reduction of a backward dislocation of the hip by upward traction on the leg which is flexed at a right angle.

in the popliteal space and above the malleoli (Fig. 772), and then certain movements are made according to one of the following methods:

If the head of the femur is still close to the posterior rim of the acetabulum, simple traction upon the thigh, which is flexed at a right angle with the trunk, is usually sufficient. Almost always, however, a definite series of movements is necessary.

Reduction by flexion, abduction, outward rotation, and then extension, after Middeldorpf and Roser, is an excellent method (Fig. 772). By forced flexion of the hip and adduction of the leg the head of the femur is lifted from the pelvis, and then by abduction and outward rotation it is turned forward into the socket. The leg is finally extended.

Kocher first rotates inward, then flexes to a right angle, draws the thigh upward, rotates outward, and extends.

Reduction is sometimes successfully effected by simple upward traction on the femur, which is in right angular flexion (Fig. 773), with or without subsequent or previous adduction and inward rotation. Here also the leg is finally abducted and extended.

That the reduction has been accomplished is shown by a characteristic snapping sound, and also by the immediate restoration of the normal mobility of the joint. In case of difficult reduction—e. g., in con-

sequence of too small a rent in the capsule—Bigelow recommends that the latter be enlarged by rotatory movements of the leg. If reduction is impossible, the joint should be exposed by aseptic arthrotomy, the obstacle removed, and the head returned into the socket, or, if necessary, resected (§ 326).

Compound dislocations of the hip are treated under antiseptic precautions and in accordance with the rules applicable to wounds of a joint (drainage and, if necessary, resection).

In case of coexisting fracture of the neck of the femur, the fracture should first be allowed to unite and then the dislocation reduced, or, in case reduction does not succeed, the formation of a nearthrosis in a good position should be striven for. Immediate resection of the femur may be necessary in some cases.

As regards after-treatment, the patient must be kept in bed for two or three weeks, and the hip joint may be immobilized by means of a spica bandage. After about three weeks the patient is allowed to practise walking, and use is made of massage and electricity. In case of a tendency to recurrence—e. g., in consequence of fracture of the acetabulum—extension is applied for five or six weeks with the leg in abduction and outward rotation.

In old dislocations also one should always attempt the above-given methods of reduction. If reposition proves unsuccessful, an attempt should be made to bring about a nearthrosis with the leg in a good position, or resort to an operation (see page 692).

II. Forward Dislocations.—We distinguish two principal forms: *a.* Dislocation forward and upward upon the os pubis (suprapubic dislocation). *b.* Dislocation forward and downward beneath the horizontal ramus of the os pubis (infrapubic dislocation). The forward dislocations are rarer than those in a backward direction. They arise usually from overextension (but also from flexion), with abduction and rotation outward. Either the thigh or the pelvis executes the abnormal movement.

(*a.*) Suprapubic dislocation (Fig. 774) arises usually from violent backward flexion of the trunk, with abduction and outward rotation of the leg—e. g., in case a person is buried up or falls upon the feet from a considerable height with the legs abducted and everted. In very rare cases the dislocation has been seen to occur from direct violence, acting upon the thigh from behind, so that the femur is pressed forward and upward. The rent in the capsule is found, as a rule, in the anterior and upper part, to the inner side of the ilio-femoral ligament. Various subforms are distinguished, according to the location of the head upon the os pubis. The ilio-pectineal dislocation is the most

frequent—that is, the head rests upon the ilio-pectineal eminence, or still farther inward upon the horizontal ramus of the os pubis (pubic dislocation). If, on the contrary, the head is external to the ilio-pectineal eminence just beneath the anterior superior spine, the dis-

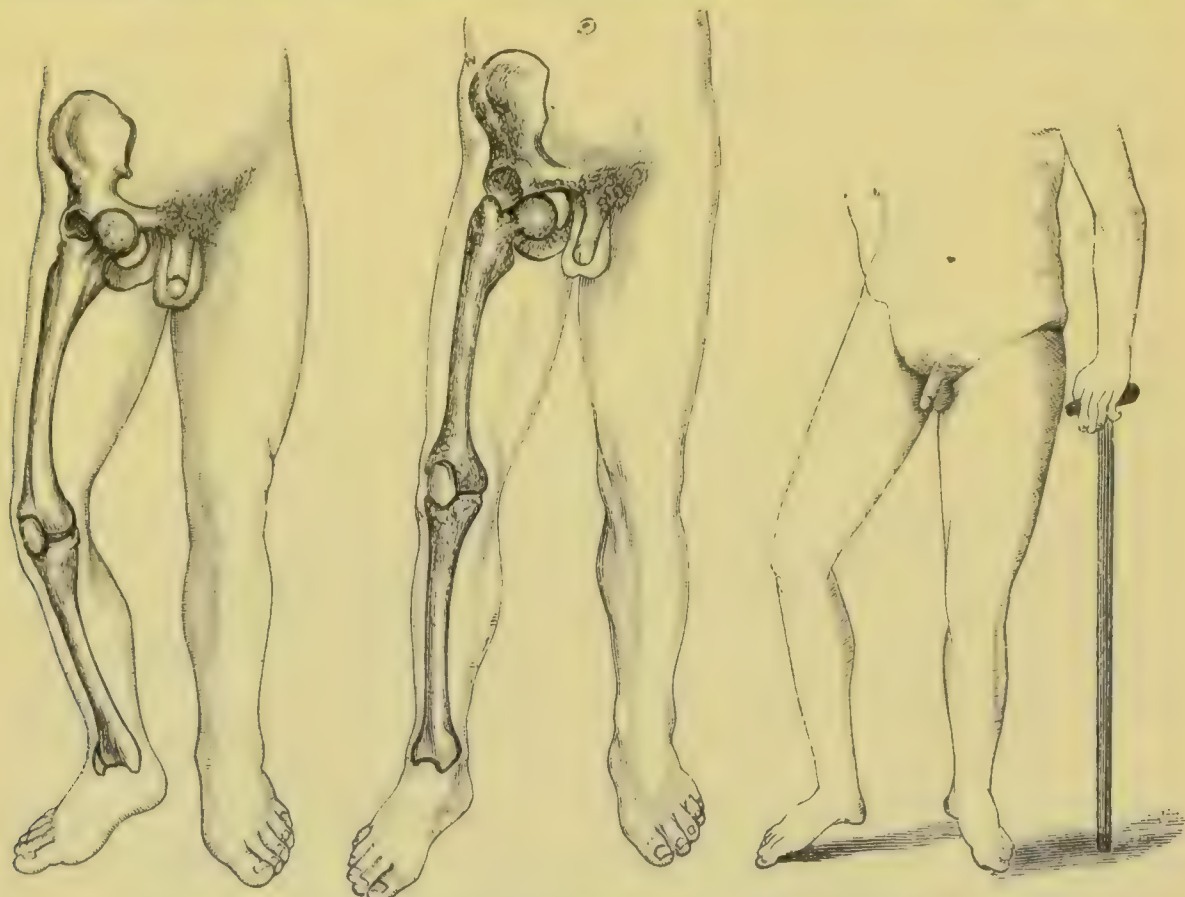


FIG. 774.—Suprapubic dislocation.

FIG. 775.—Infrapubic dislocation.

FIG. 776.—Suprapubic dislocation.

location is also called a subspinous dislocation (Bigelow). Scriba observed a special form of suprapubic dislocation which he called intrapelvic—that is, the head rests upon the linea ilio-pectinea of the pelvis, and the trochanter on the horizontal ramus of the os pubis and the anterior inferior spine of the ilium.

(b) Infrapubic dislocation arises ordinarily from abduction with strong flexion and eversion, and in rare cases, like the suprapubic dislocation, from the action of direct violence against the trochanter. The rent in the capsule is found usually in its anterior and lower part to the inner side of the ilio-femoral ligament. The head usually rests upon the obturator foramen (obturator dislocation, Fig. 775), or, very rarely, still farther inward upon the ascending ramus of the ischium (perineal dislocation), especially when the thigh is sharply flexed at the moment the violence acts. As already remarked, a backward dislocation—e. g., an ischiatic dislocation—can arise secondarily from an obturator dislocation by inward rotation, for instance, in that the head

of the bone glides backward along the lower rim of the acetabulum. Various authors, in fact, hold the view that the primary obturator dislocation is the most common form of dislocation, which either persists or passes over by secondary movement of the head of the bone into a backward dislocation. It is, at any rate, a fact that in a backward dislocation the rent in the capsule is sometimes found behind and sometimes in front. An obturator dislocation can also easily arise from too great flexion of the femur in effecting the reduction of a dislocation.

The symptoms of forward dislocations are slight flexion at the hip, abduction, and eversion (Figs. 774–778). This typical deformity changes somewhat according to the location of the head of the bone.

Suprapubic Dislocation.—In suprapubic dislocation, with its above-described varieties (ilio-pectineal, pubic, subspinous, and intrapelvic dislocations), the flexion, abduction, and outward rotation are the more marked the farther inward the head of the bone is situated (Figs. 774 and 776). The dislocated head of the bone can usually be felt through the tensely stretched soft parts over the os pubis, and in fresh cases where there is not much swelling and extravasation of blood its outline can be seen. The anterior crural nerve runs over the dislocated head of the bone, and thus are explained the pain and the feeling of numbness in the leg. The femoral artery lies to the inner side of the head of the bone and sometimes over it. The leg is shortened, because the head of the bone lies above the acetabulum, the gluteal region is flattened, the gluteal fold is obliterated, and the trochanter is not in its normal place, but has deviated in an inward direction and lies opposite the acetabulum. The hip joint is fixed, is not at all movable actively, and only slight abduction and outward rotation are possible passively. In the intrapelvic variety observed by Scriba the leg, which is flexed at the hip, is, contrary to the typical position, adducted and rotated inward. The dislocation is sometimes complicated by fractures—e. g., avulsion of a portion of the great trochanter, or fracture of the rim of the acetabulum, etc.

The diagnosis of a suprapubic dislocation is usually easy to make from the typical deformity and from the immobility of the leg in its abnormal position.

The prognosis of a pure, uncomplicated suprapubic dislocation is better than that of any other dislocation of the hip. No injurious effects result, as a rule, after reduction. Even if reduction is not effected, the ability to walk may be comparatively good, as Lossen has stated, basing his opinion upon two cases reported from the literature of the subject. Flexion at the hip and knee is, however, either considerably impaired or wholly suspended, as the flexor muscles of the leg, arising from the tuberosity of the ischium, can not perform their function normally.

Infrapubic Dislocation.—We have become acquainted with two forms of infrapubic dislocation—the obturator and the very rare perineal dislocation.

In the obturator dislocation (Figs. 775, 777) the leg is slightly flexed, abducted, and everted. The views of authors differ as to whether the dislocated extremity is shortened or lengthened. The leg would naturally be a little shortened (Malgaigne), because the dislocated head of the femur, in consequence of the elastic tension of the soft parts, is carried by a secondary movement to the inner or upper border of the obturator fora-

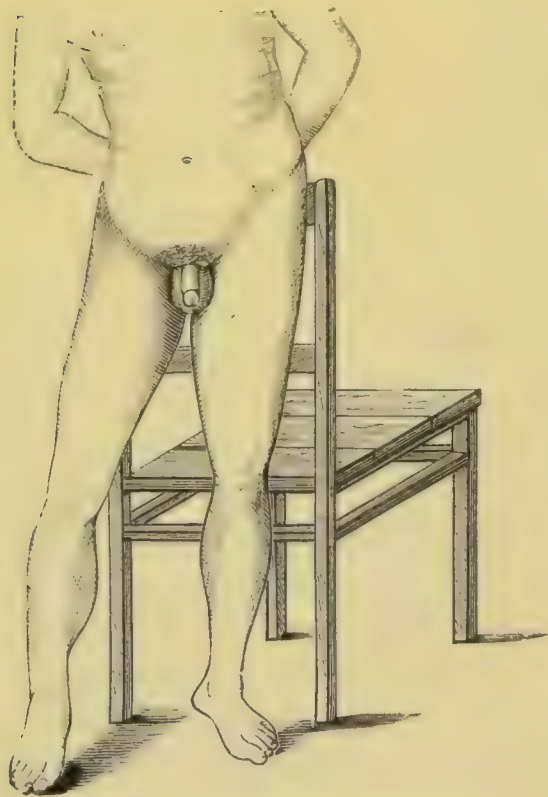


FIG. 777.—Obturator dislocation.

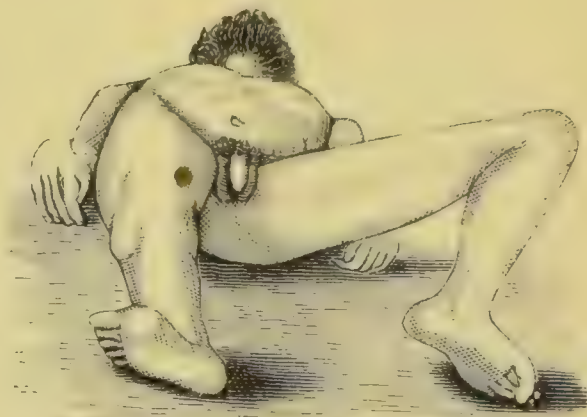


FIG. 778.—Perineal dislocation (Bigelow).

men. The abnormal position is more striking when the patient lies down than when he stands, because in the latter case the deformity is partly compensated for by the lordosis of the spine and increased inclination of the pelvis. The region of the hip is flattened and depressed near the great trochanter, and the head of the bone can generally be felt under the abductors and through the rectum, especially if it is made to rotate. The hip joint is completely immovable actively, and only slight abduction and flexion are possible passively. Sometimes, however, the patient can walk for some distance immediately after the accident. Severe pain is sometimes caused by pressure of the head of the bone upon the obturator nerve.

In the second and rare form of infrapubic dislocation, the perineal dislocation, the marked abduction and flexion of the leg are characteristic (Fig. 778). The head of the bone can be felt under the adductor muscles behind the scrotum. Riedinger, after an observation of his own in the case of a boy fourteen years old, collected from literature

eight cases of this very rare perineal dislocation, all being males from nineteen to fifty-one years of age. Spontaneous and paralytic perineal dislocations have also been observed (Pitha, P. Bruns, Karewski).

The prognosis of infrapubic dislocation after a successful reduction is usually favourable. If reduction is not effected, the ability to walk is still satisfactory after an obturator dislocation, because the head of the bone is supported in the obturator foramen against the horizontal ramus of the os pubis. The prognosis is much less favourable in case of non-reduction of a perineal dislocation, because walking and standing are scarcely possible on account of the marked abduction and flexion of the leg.

The reduction of a suprapubic dislocation is best effected by extension or hyperextension of the abducted and everted leg, also by acute-angled flexion, adduction, and rotation inward. For the sufficient execution of hyperextension it is advisable that the patient be placed upon the edge of a table, and here also the pelvis is, of course, to be fixed by an assistant. The dislocated head of the bone is lifted from the os pubis by the extension or hyperextension, then brought near the upper rim of the acetabulum by acute-angled flexion, braced against the rim of the acetabulum by adduction, and turned into the socket by inward rotation.

Roser and Kocher lay stress upon the use of direct pressure upon the dislocated head of the bone. The latter is pressed against the acetabulum with the hand, after extension and hyperextension of the abducted and everted leg; then follows flexion of the thigh to a right angle, and finally rotation inward.

In case of incomplete suprapubic dislocation, reduction is successfully accomplished by flexion of the thigh to a right angle and rotation inward.

In infrapubic dislocation (obturator and perineal dislocation) reduction is most easily effected by flexion of the leg in its abnormal position to a right angle, upward traction on the thigh, and then rotation inward and adduction. Kocher recommends flexion of the thigh to a right angle, upward traction, and rotation outward.

As regards the after-treatment, or the treatment of any complications, the same rules apply to forward dislocations that we gave above on page 685. If reduction proves unsuccessful, one should here also expose the joint, remove the obstacle, and reduce the head or perform resection of the femur. For the treatment of old dislocations, see page 692.

III. Upward Dislocation (Supraglenoid or Supracotyloid Dislocation).—The Blasius brothers collected from the literature of the subject twenty-

three cases of this rare form of dislocation. The head of the femur lies above the acetabulum (Fig. 779), either directly below or above



FIG. 779.—Supracotyloid dislocation of the hip.

the anterior inferior spine or somewhat to the outer side of the same. The leg is extended, everted, slightly adducted, and shortened. The head of the femur can easily be felt in the region of the anterior inferior spine of the ilium, and can usually be distinctly seen if there is not much swelling. The hip is incapable of active movement and of but very slight passive movement. Scriba's intrapelvic and Bigelow's subspinous dislocation, which were mentioned above, can also arise from a supracotyloid dislocation of the femur, and may therefore be regarded as a subvariety of this dislocation.

Bigelow described a form of supracotyloid dislocation in which, as the result of extensive injury of the soft parts and rupture of the ilio-femoral ligament, the dislocated thigh is so strongly adducted that it crosses the sound one in an oblique direction (oblique dislocation).

From an etiological standpoint primary and secondary upward dislocations are to be distinguished. This dislocation sometimes occurs sec-

ondarily, as has been said, from an iliac or ilio-pectineal dislocation (Roser, Hueter), and many authors even regard it as a subform of the iliac dislocation, the more so as the capsule is usually torn posteriorly. The primary supracotyloid dislocation arises most frequently, no doubt, from hyperextension with marked adduction and outward rotation, also from flexion, adduction, and outward rotation.

As regards the diagnosis of supracotyloid dislocation, it should be noted that its symptoms are similar to those attending ilio-pectineal dislocation or fracture of the neck of the femur. A correct diagnosis can easily be made, however, by an exact determination of the position of the head of the bone.

The prognosis of supracotyloid dislocation of the femur is favourable after successful reduction. In old, unreduced dislocations even the ability to walk is satisfactory, because the head of the bone is braced against the anterior superior spine of the ilium.

The reduction of supracotyloid dislocation of the femur is most successfully effected by flexion of the adducted leg with downward traction and rotation inward. It is a very good plan to attempt at the

same time to bring the head of the bone opposite the acetabulum by direct pressure from above. One can also, after Hueter and others, change the upward dislocation by sharp flexion and rotation inward into an iliac dislocation and then reduce this in the manner before described.

IV. Downward Dislocation (Infraglenoid or Infracotyloid Dislocation).—In this very rare form of dislocation the head of the bone rests on the lower rim of the acetabulum or on the tuberosity of the ischium. The deformity is very characteristic (Fig. 780). The thigh is in nearly right-angular flexion at the hip, is somewhat abducted and everted, and the knee joint is flexed. The hip is immovable actively, while passively rotation is least interfered with. The dislocated head of the bone is usually to be felt only with difficulty through the thick layers of muscle. In other cases the position of the leg is less typical, and according as the head is displaced more forward, upward, and inward or backward, the more does this dislocation resemble an obturator or an ischiatic dislocation. The position of the leg is especially irregular when the ilio-femoral ligament is ruptured.

Dislocation downward arises essentially from the same kind of violence as that causing ischiatic and obturator dislocations, except that the leg is not rotated. A downward dislocation has also been known to occur from a direct blow upon the knee with the thigh flexed. The head usually, however, does not remain below the articular cavity or on the tuberosity of the ischium, but slips forward, upward, and inward or backward—that is, there arises secondarily either an obturator or an ischiatic dislocation. The reverse is also true—viz., that in the reduction of the latter dislocations an infracotyloid dislocation arises.

The extreme flexion of the leg, which occurs in no other dislocation of the hip, is especially characteristic for the diagnosis of a typical infracotyloid dislocation, and also the circumstance that the head of the bone is not to be found at the other places of dislocation, and is, in general, difficult to feel.

The prognosis of an infracotyloid dislocation is favourable. In old, unreduced dislocations the ability to walk may be satisfactory in case the head of the bone is supported against the lower rim of the acetabulum.

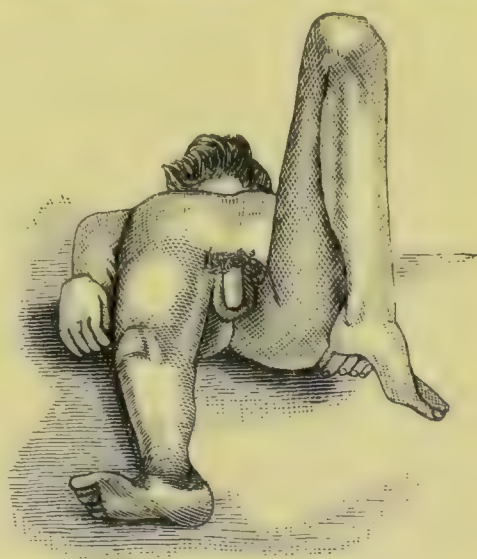


FIG. 780.—Infracotyloid dislocation of the hip (Bigelow).

The reduction of an infracotyloid dislocation is effected by upward traction with the leg in the position caused by the dislocation, rotation outward, and extension. It is a good plan also to increase the existing flexion at the beginning of the attempt at reduction, in order that the head of the bone may slip upward and inward and approach the location that it has in an obturator dislocation. The reduction of the latter can then be effected in the manner given above.

Dislocation into the pelvis through the fractured floor of the acetabulum has been described in § 259, page 477, *Surgery of the Pelvis*.

The treatment of old, unreduced dislocations of the hip is often attended with great difficulties. Reduction is undertaken in such cases, generally speaking, in accordance with the above-described methods, but it is rendered difficult, or sometimes wholly impossible, in consequence of changes in the acetabulum and the capsule, as well as of contraction and shrinkage of the fasciæ, the ligaments, and the muscles. Aside from exceptional cases, in which reduction is said to have been effected after the expiration of years, the longest period that has elapsed before successful resection is, according to Nélaton, nine months. This case, however, is not a perfectly sure one.

Reduction is attempted with the patient under the full influence of an anæsthetic and with the greatest caution. The mechanical aids which were formerly much used, such as pulleys, have been entirely abandoned in modern surgery. If reduction proves impossible, one should either strive to secure a nearthrosis with the leg in a good position or resort to an operation. In cases where the leg is of but little use and the dislocation is not of too long standing, one will expose and open the joint and bring the head back into the socket or resect the head. Resection yields comparatively the best functional results in cases of long standing (K. Kirn). If one gives up reduction of the dislocation and strives merely to improve the abnormal position of the leg, osteotomy above or below the trochanter can be performed. Old backward dislocations have been most frequently treated by operation, because the functional disturbances are greatest in them. Still, as we have stated on page 683, there are cases of unreduced backward dislocations in which the ability to walk is strikingly good.

Niehans, besides a case of his own, collected from literature twenty-six cases of bilateral traumatic dislocation of the hip. In four cases the heads of both femurs were dislocated forward, and four times both were dislocated backward. In the remaining cases there were different forms of dislocation on the right side and on the left. Reduction was successful in twenty cases, four remained unreduced, and one died in consequence of the resection that was performed. Bilateral dislocations of the hip joint arise chiefly from violence (burying up, a fall, etc.) which bends the body forcibly forward or backward—in other words, from forced flexion or extension of the hip. Some cases were caused by twisting movements or a fall upon the sharply flexed knees.

Some persons can dislocate their joints voluntarily, usually, to be sure, only partially. The voluntary incomplete dislocation of the first phalanx of the thumb is the most common. Athletes and contortionists produce by continued practice such a stretching and elongation of the articular capsules and

ligaments that they can finally produce complete dislocations at will, without rupture of the capsule, of course, and immediately reduce the same.

§ 316. **Congenital Dislocations of the Hip.**—Congenital dislocations of the hip are to be regarded essentially as foetal malformations, as cases of arrested development. These congenital dislocations are most frequent at the hip, occurring but rarely in the other joints. The traumatic dislocations at the hip that occur during birth, from extraction of the child, are to be distinguished from the congenital dislocations that originate *in utero*. The former are extremely rare, fractures at the epiphyses being far more common.

The defective, shallow development of the acetabulum has an important bearing, to begin with, upon the occurrence of congenital dislocation of the hip. This defective formation is a consequence, probably, of arrested development or premature ossification of the Y-shaped cartilage of the acetabulum (Dollinger, Grawitz). I had the opportunity to examine a congenital dislo-

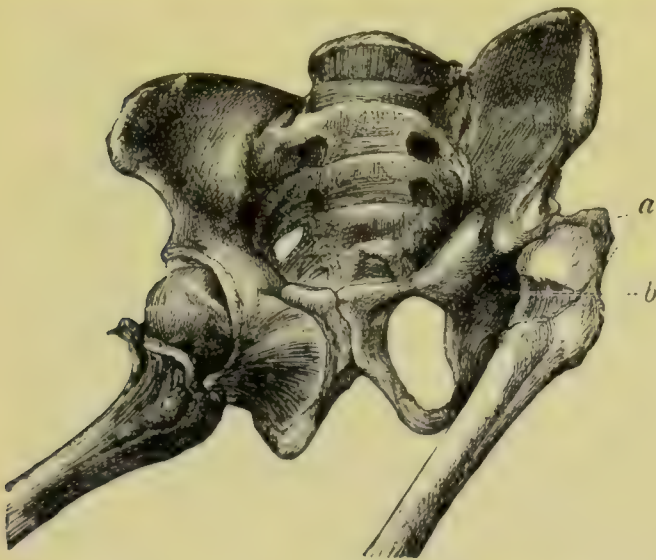


FIG. 781.—Congenital dislocation of the left hip in a female child six months of age: *a*, remnant of the capsule which has been dissected away; *b*, undeveloped acetabulum.



FIG. 782.—Development of a congenital dislocation of the hip in consequence of extreme adduction of the thighs of the foetus caused by a small uterus (Roser).

cation of the hip in the case of a girl six months of age (Fig. 781). I found an insufficiently developed, shallow acetabulum, the neck of the femur formed an obtuse angle with the shaft, and the ligamentum teres was strikingly thickened and elongated and filled the articular cavity so completely that the head which rested against the anterior superior spine had not sufficient room in the shallow cavity. The pelvis was unsymmetrical, but the capsule was normally formed. It is my opinion that a congenital malformation of the head and neck of the femur—as, for example, in Fig. 781—also plays an important part in the development of dislocation of the hip, in that the head of the femur then, as it were, grows by the acetabulum. This deformity, this obtuse-angled insertion of the neck of the femur on the shaft, is explained perhaps by the position of the foetus in the uterus. Dupuytren, Roser, and others have rightly emphasized the fact that the development of a congenital dislocation

of the hip is favoured by sharp flexion and extreme adduction of the femurs of the foetus, especially in an abnormally small uterus (Fig. 782). The fact is also of importance, for the etiology of congenital dislocation of the hip, that it is observed much more frequently in females. According to Krönlein, 87.6 per cent of all congenital dislocations of the hip were in females. From my own studies of the foetal pelvis, I am disposed to refer this fact to the more perpendicular position of the iliac bones in the female sex, in consequence of which the head of the femur more easily slips upward from a shallow acetabulum upon the ilium or grows by the socket, if the malformation of the head and the neck of the femur represented in Fig. 781—that is, the obtuse-angled position of the neck of the femur with reference to the shaft—exists. The main factor in congenital dislocation of the hip is, therefore, a malformation of the entire joint, affecting not only the acetabulum but also the femur as well. The ligamentum teres is sometimes wanting, especially in older children and in dislocations of both hips. Out of nineteen cases of double dislocation, Hoffa found it present in only four, while out of thirty-one cases of single dislocation that were operated upon it was absent in only five.

The clinical appearance of a congenital dislocation of the hip is extremely characteristic. It is more frequently single than double. Kirmisson observed fifty-one single and thirty-one double dislocations, and Hoffa one hundred and ninety-eight single and one hundred and thirty-four double. The dislocation is usually of the supracotyloid variety at the outset—i. e., the head lies above the acetabulum, below and somewhat to the outer side of the anterior superior spine. Subsequently, as the result of walking, the head moves backward upon the dorsum of the ilium, and one usually finds an iliac dislocation. The head can easily be felt on the ilium by rotating the same, the trochanter lies above Nélaton's line, the leg is correspondingly shortened, and the upper gluteal region is abnormally prominent. The muscles passing from the pelvis to the thigh are shortened and, especially in double dislocation, the pelvis is inclined forward, causing a lordosis of the lumbar vertebræ (Fig. 783). The gait of the patient is thoroughly characteristic. He waddles like a duck, especially in double dislocation, because in walking he is obliged to throw himself, as it were, quickly from one leg upon the other, in consequence of insufficient fixation of the head of the femur. Trendelenburg showed that this peculiar gait is due to the fact that the abductors of the hip (the glutæus medius and minimus and in part the glutæus maximus), in consequence of their atrophy, changed direction, and shortening, are unable to hold the pelvis in a horizontal position, but allow it to slant over to one side each time the patient takes a step. Esmarch observed such extreme adduction of the thighs in a case of double dislocation of the hip that in walking and standing the legs lay crossed upon one another (Fig. 784).

The prognosis of congenital dislocation of the hip is particularly unfavourable in older children. An effectual treatment is usually very



FIG. 783.—Congenital dislocation of both hips.



FIG. 784.—Congenital dislocation of both hips in a girl twelve years of age with extreme adduction of the thighs. The latter remained crossed in standing and walking (Esmarch).

difficult. Immobilization splints, extension splints, with or without subcutaneous tenotomy, particularly of the adductor muscles, supporting apparatus, such as leather corsets with supports on the trochanter, accomplish, as a rule, little or no permanent good. A well-fitting jacket of felt with water-glass and shellac (Fig. 785) made over a plaster-of-Paris model will, however, often improve the waddling gait. Schede's splint apparatus, which combines abduction at the hip with lateral pressure on the trochanter, and Mikulicz's apparatus, are both to be recommended. Hessing obtains very good results with his immobilization splints. Paci claims to have had very satisfactory functional results from the following method,

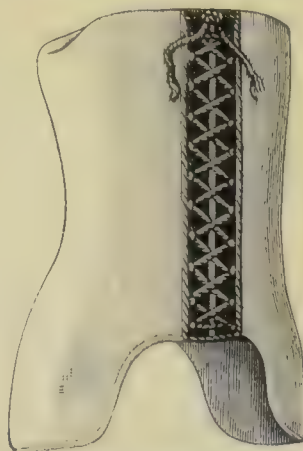


FIG. 785.—Jacket for congenital dislocation of the hip.

which is continued for a year : The patient having been anæsthetized, the head of the femur is pressed downward with the thigh flexed, and this is followed by abduction and gradual extension. Use is then made for a month or two, while the patient remains in bed, of an immobilization splint for the hip, and of permanent extension by weights for a month or longer. The patient then walks with crutches for some months, and finally with a cane. Lannelongue caused the formation of a ridge of bone by the injection of two drops of a ten-per-cent solution of chloride of zinc into eight places around the upper posterior periphery of the rim of the acetabulum. The injection was repeated after three weeks. The leg was immobilized by an extension splint during the entire time of the treatment. Operative treatment has again come into favour. Hoffa, in particular, has attempted to improve the condition—that is, to secure better ability to walk—by the fixation of the head of the bone in a newly formed socket. The operation is especially adapted to young children from three to six years of age ; the older the child, the more marked is the deformity of the head and neck of the femur, so that a good result can hardly be expected. According to Hoffa, the operation is most likely to be successful when the ligamentum teres is preserved. The absence or presence of this ligament can be determined in the following simple way : The hand is placed upon the joint and passive movements are made, and if a peculiar creaking, snapping noise is perceived, the ligament is absent ; otherwise it is present. This ligament makes, according to Hoffa, all subcutaneous attempts at reduction impossible, and hence operation is indicated in case it is present. If the ligament is absent, orthopædic treatment may then be successful. Resection of the hip is to be discarded, because the leg is shortened thereby and the patient limps as before. Hoffa recommends exposing the head of the bone by Langenbeck's incision for resection, and freeing it subperiosteally from the muscular insertions on the greater and lesser trochanter, so that it can be drawn down into the region of the acetabulum. If there is a socket, the head of the bone is replaced. If the socket is absent, or, as is usual, there is simply a suggestion of one, it is chiselled out to a sufficient size after the periosteum in the neighbourhood has been lifted up in the form of a flap. Tenotomy of the adductors, the muscles that are attached to the anterior superior spine, and the hamstring tendons was at one time resorted to in order to facilitate reposition of the head of the femur into the new socket ; but this is unnecessary, with the exception, possibly, of tenotomy of the adductors. Lorenz's operation is preferable, which consists in opening the joint from in front by means of Hueter's incision (page 746) and sparing the muscular insertions at the upper end

of the femur. Reposition of the head into the new hollowed-out socket is sometimes very difficult, and forcible extension has to be repeated a number of times. The shortened adductor muscles are the chief obstacles to reduction (Lorenz). After successful reduction of the head the wound is sutured and a strip of iodoform gauze is inserted in the centre or the lower angle of the same. A plaster splint is applied over the aseptic protective dressing, and is kept on for three or four weeks. Lorenz obtained good results with his operation, but other operators not so good, and the general opinion regarding its value is still undecided. With strict asepsis the operation is, at any rate, not dangerous. Lorenz has not had a death among his last hundred cases, but there were several cases of sepsis at first. König, Riedel, and others have attempted to form an artificial socket by chiselling up a flap of periosteum and bone which afterward surrounds the head of the femur above and on the outer side like a concave shell. König secured in one case a thoroughly satisfactory result. There was found at the autopsy of the child, who died of diphtheria four months after the operation, a high ridge of bone which served, as it were, as a posterior and superior acetabular margin. Gussenbauer and the author have also employed this method, with good results. Kirmisson has obtained good results in older children by subtrochanteric osteotomy.

There remains to be mentioned the nailing of the denuded head of the bone into the socket as a means of securing ankylosis of the joint. In case the femur is much deformed, fixation of the latter in an artificial socket is impossible, and in such cases Hoffa recommends sawing off the deformed portion of the femur, freshening the iliac bone, bringing the sharply abducted end of the femur in contact with the ilium, and striving for a firm pseudarthrosis.

§ 317. **Pathological Dislocations of the Hip Joint.**—We shall study the so-called pathological or spontaneous dislocations of the hip more in detail when treating of the diseases of this joint. They are a direct result of the latter, and arise either from abnormal stretching and relaxation of the capsule and the ligaments, or from a change in the form of the head of the femur or of the acetabulum—e. g., in consequence of tuberculosis (caries) or arthritis deformans, or, finally, from paralysis of the muscles. The dislocation or displacement of the head of the femur either follows very gradually or more suddenly from a slight traumatism or muscular action.

We distinguish the following pathological dislocations :

1. *Distention dislocations* in consequence of stretching or relaxation of the capsule and articular ligaments—e. g., from a large serous, sero-fibrinous, or suppurative effusion into the joint in the course, for instance, of typhoid fever, smallpox, measles, scarlet fever, diphtheria, puerperal fever, or pyæmia. Verneuil saw spontaneous dislocation of the hip joint in five cases of acute articular rheumatism, in consequence of relaxation of the lig-

amentous apparatus and muscular traction. Reduction was successful at once with the patient under an anæsthetic. The voluntary dislocations mentioned above, on page 692, also belong to the distention dislocations, as do the paralytic dislocations.

We must speak somewhat more in detail of paralytic dislocations. Verneuil, Reclus, and others were the first to describe at length the remarkable cases of spontaneous dislocation of the hip in connection with infantile paralysis. They were at one time incorrectly regarded as cases of congenital dislocation. There are essentially two classes of paralytic dislocation of the hip—viz., those associated with partial paralysis of individual muscles or groups of muscles of the hip or of the thigh and the pelvis, and those with complete paralysis of the leg (Albert). In cases of the first class the location or the extent of the paralysis determines the direction of the dislocation. If the external rotators and the abductors are sound, pubic dislocation ensues; if the internal rotators and the adductors are intact, iliac dislocation results (Albert). There is no effusion in the joint attendant upon paralytic dislocation. This form of dislocation is due mainly to the unopposed contraction of certain muscles whose antagonists are paralyzed. In the cases reported by Karewski there was paralysis of the extensors and adductors, and a contraction of the flexors ensued with gradual stretching of the posterior and inferior parts of the capsule. The capsule and the articular ligaments are stretched more and more by the weight of the extremity, because the latter, in consequence of the muscular paralysis, is not sufficiently supported and not firmly held. In consequence of this increasing relaxation of the capsule and the articular ligaments, as well as in consequence of the enlargement of the joint, the head of the bone finally leaves the joint—e. g., in case of a contracture of the flexors—and passes in a downward and inward direction upon the descending ramus of the os pubis. The dislocation then becomes more and more fixed by contraction of the ilio-femoral ligament and of the anterior portion of the capsule. In two cases of paralytic dislocation of the hip in little children Karewski exposed the joint by Hueter's anterior longitudinal incision (see § 326), as reduction with the child under an anæsthetic did not prove successful, and effected reduction after the antagonistic muscles, especially those inserted on the trochanter, had been detached. The result was very good. In case paralysis of the knee and the ankle exists at the same time, the formation of an artificial ankylosis of these joints by arthrodesis might be advisable (see Principles of Surgery, page 133), in order to render the use of mechanical appliances unnecessary.

2. *Destruction dislocations* arise after carious destruction of the head of the bone and the acetabulum. They are the most common form of pathological dislocation. They occur in connection with morbus coxæ (see Fig. 795, page 712), and with spondylolisthesis—that is, the slipping forward of the fifth lumbar vertebra into the pelvis—e. g., after tubercular destruction of the involved articulation (see vol. ii, § 147, page 825).

3. *Deformation dislocations* are conditioned upon changes of form in the head of the femur and the acetabulum, particularly atrophy of the bone without suppuration and without granulating inflammation of the joint. They occur most commonly in connection with arthritis deformans (see page 721).

We shall come back to the treatment of pathological dislocations in connection with the different forms of arthritis. In all cases in which manual or operative reduction is practicable this should be undertaken.

§ 318. **Fractures of the Upper End of the Femur.**—We distinguish the following forms of fracture at the upper end of the femur: 1. Fracture of the head of the femur. 2. Separation of the epiphysis. 3. Fracture of the neck of the femur. 4. Fracture of the great trochanter. For fractures of the acetabulum see § 259, page 477 (Fractures of the Pelvis).

1. **Fracture of the Head of the Femur.**—This fracture is not frequent. The ligamentum teres sometimes tears out a piece of bone from the caput femoris in dislocation of the hip. Contusions of the head or its cartilaginous covering also frequently occur in connection with dislocations. A fracture by compression arises in rare cases from a fall upon the feet or the trochanter (Dupuytren). Riedel observed a longitudinal fracture of the head and neck of the femur. Finally, the shattering of the head of the femur in gunshot wounds should be mentioned. The symptoms, the course, and the treatment of the extremely rare fractures proper of the head of the femur are essentially the same as those of intracapsular fractures of the femur, to which the reader is accordingly referred.

2. **Separation of the Epiphysis of the Head** occurs in rare cases in individuals averaging from fourteen to fifteen years of age. Tubby has found nine indisputable cases. Some surgeons have doubted the occurrence of these rare separations of the epiphysis. They are usually the result of severe violence, such as being run over. As the growth of the femur depends mainly upon the lower epiphysis, its subsequent shortening is usually unimportant. Important diagnostic factors are: Youth of the individual, soft cartilaginous crepitus, but slight shortening and eversion, and good function even without bony union. For the symptoms and treatment see Intracapsular Fractures.

3. **Fracture of the Neck of the Femur.**—The line of fracture is found either at the junction of the head with the neck—that is, it has an intracapsular location (Fig. 786, 1)—or it is at the base of the neck, outside of the joint (Fig. 786, 2 and 3). Fractures near the head are always pure intracapsular fractures, while those at the base of the neck are usually partly extracapsular and partly intracapsular. Fractures in the middle of the neck are the most rare. Fractures of the neck of the femur near its head have also been called fractures of the anatomical neck, after the analogy of fractures at the upper end of the humerus; and those at the base of the neck, fractures of the surgical neck.

A very important distinction, from a clinical and therapeutical point of view, is that between impacted and non-impacted fractures of the neck. In impacted fractures (Fig. 787) one fragment is firmly driven into the cancellous tissue of the other. This impaction of the fragments occurs much more frequently in fractures of the neck of

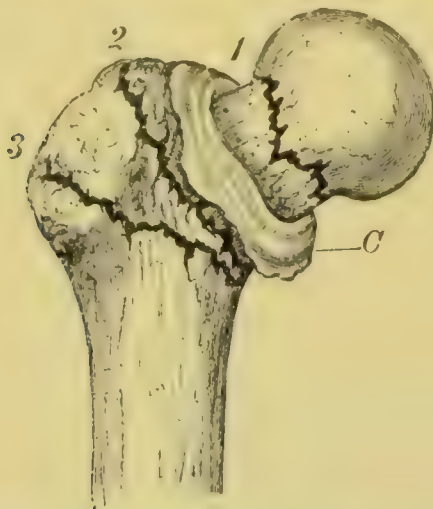


FIG. 786.—1, intracapsular; 2 and 3, extracapsular fracture of the neck of the femur; C, capsule (diagrammatic).

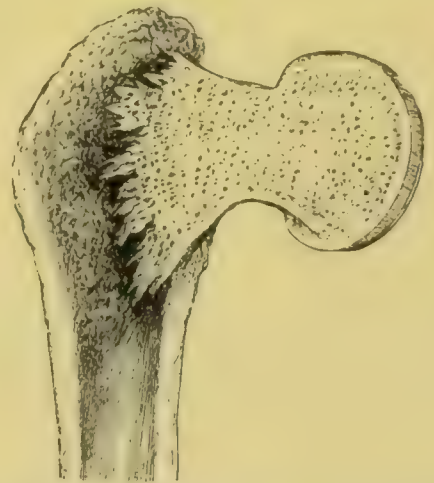


FIG. 787.—Impacted fracture of the neck of the femur.

the femur near the trochanter than in the pure intracapsular fractures near the head of the femur. In the latter the neck is driven into the cancellous tissue of the head, and in fractures near the trochanter the neck is driven into the cancellous tissue of the trochanter. In this impaction of the fragments their position either remains unchanged or the impaction is combined with displacement of the fragments—e. g., the head may have moved downward, upward, or backward. The impaction is sometimes only incomplete, especially in case of displacement of the fragments, where, for instance, only the posterior or inferior edge of the neck may be driven into the cancellous tissue of the other fragment. The neck of the femur is, of course, always shortened in consequence of the impaction. Impaction is always favourable for the course of a fracture of the neck of the femur, because bony union is naturally facilitated thereby, especially in the pure intracapsular fractures, in which bony union does not usually take place *without* impaction.

In all non-impacted fractures of the neck of the femur there is usually a corresponding displacement of the fragments, and consequently a marked shortening of the extremity, because the lower fragment is drawn backward and upward by the action of the muscles. The leg is usually everted in consequence of its own weight.

In incomplete fractures of the neck of the femur, its superior, inferior, or posterior surface may be broken through, while the opposite

cortical portion is intact ("green-stick" fractures). They are usually intracapsular.

Fractures of the neck of the femur are of rare occurrence among children and young persons. They are most frequently observed among individuals over fifty years of age, and more frequently among women than men. This greater frequency of fracture of the neck of the femur among persons of advanced age is due to its increasing senile atrophy. The compact portion is reduced in consequence of this senile osteoporosis, and the so-called femoral spur (*calcar femorale*, Merkel) atrophies more and more. By the femoral spur, which is a very important support of the neck, is understood that compact layer of bone which extends from the lesser trochanter into the cancellous tissue of the neck of the femur and passes over beneath the head of the same into the anterior surface of its neck. The firmness and the resistance of the neck of the femur are also dependent upon its structure and the arrangement of its cancellous tissue. We know, as a result of the investigations of Culmann, Meyer, Julius Wolff, Riedinger, and others with reference to the structure of the neck of the femur, that the arrangement of the cancelli is such as to withstand most effectually pressure in all directions. This arrangement of the cancelli also changes with increasing age. It can thus be understood that the neck of the femur has less power of resistance among older people, and may be broken by the action even of comparatively slight violence.

If we leave gunshot fractures out of consideration, fractures of the neck of the femur almost always arise from indirect violence, especially from a fall upon the great trochanter, upon the buttocks, upon the feet, or upon the knee. The neck is either bent or wholly broken, with or without complete or partial impaction of the fragments. In case of a fall upon the great trochanter there ensue, as a rule, as shown by clinical experience and by the experiments of Heppner, Riedinger, Lardy, and others, fractures of the base of the neck—that is, near the trochanter—whereas by a fall upon the feet or the knee pure intracapsular fractures of the neck at its transition into the head usually result, because in the latter case the violence acts in the longitudinal axis of the femur. In making a misstep, or when a person is in danger of falling backward and strives forcibly to hold himself erect, fractures of the neck ensue from traction of the ilio-femoral ligament, as has been verified experimentally also by Linhart and Riedinger. The neck of the femur is hereby completely or incompletely torn away from the shaft in the region of the trochanter, and the ilio-femoral ligament remains connected with the fractured neck. Fractures of the neck are produced in rare cases by muscular traction—e. g., in heavy lifting or in violent movements of the hip joint which overstep the physiological limit. In the latter case dislocation may arise first and then fracture of the neck.

The symptoms of fracture of the neck of the femur are different in impacted and non-impacted fractures, as they are also in intracapsular and extracapsular fractures. The most important symptoms are eversion and shortening of the leg. Both symptoms are less pronounced in impacted than in non-impacted fractures.

Eversion of the thigh is a result simply of the weight of the limb, because its normal support—the neck of the femur—is broken. The leg is inverted in rare cases of unimpacted fracture of the neck

of the femur, when, for example, the broken limb is turned inward in transporting the patient, or by the patient himself.

In impacted fractures the eversion may be absent altogether. Its degree depends, generally speaking, upon the greater or less amount of impaction of the posterior part of the surface of the fracture.

The amount of shortening of the leg is likewise different in impacted and non-impacted fractures. In impacted fractures it is always trivial, usually amounting to less than two centimetres, while in unimpacted fractures it may be considerable, especially in unimpacted extracapsular fractures. The shortening may here amount to eight or ten centimetres, because the shaft is drawn upward and backward by the muscles (Fig. 788). In non-impacted intracapsular fractures the shortening is less, because much displacement of the fragments is prevented here by the capsule. In such intracapsular fractures, therefore, the shortening seldom amounts to more than three centimetres. It is, however, worthy of notice, from a diag-

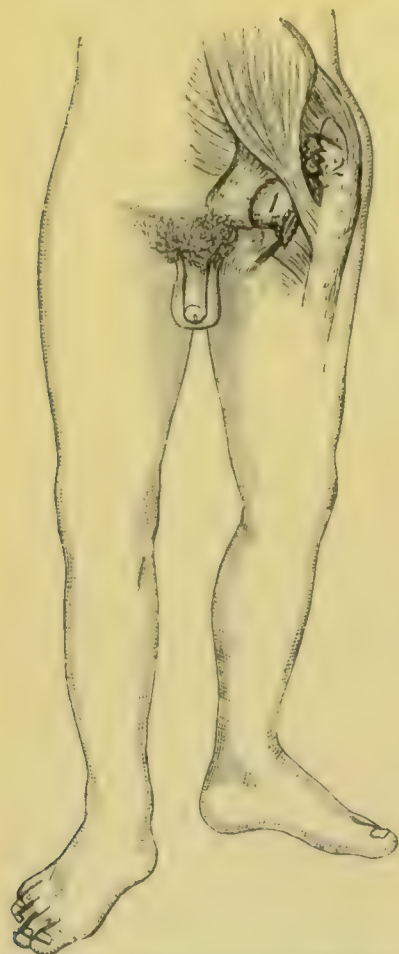


FIG. 788.—Extracapsular fracture of the neck of the femur with displacement of the lower fragment (2) upward and backward; 1, upper fragment (diagrammatic).

nostic point of view, that this shortening can gradually become more marked in consequence of increasing relaxation and stretching of the capsule.

Crepitus and abnormal mobility are naturally absent in impacted fractures. They are usually easily demonstrable in non-impacted fractures by making rotatory movements, which are to be carefully executed, or upon pressure on or behind the trochanter. Passive movements must be executed with the greatest care in all impacted fractures, lest the fragments be separated and bony union prevented thereby.

The position of the trochanter is changed, especially in non-impacted fractures. It is displaced upward and backward (Fig. 788) according to the amount of the shortening and eversion of the leg, and lies, it may be, several centimetres above Nélaton's line. In impacted fractures the trochanter is displaced inward in consequence of the

shortening of the neck—that is, it is less prominent, and the space between the trochanter and the crest of the ilium is, as compared with the sound side, more sunken and depressible, in consequence of the relaxation of the tensor fasciæ latae and of the muscles of the gluteal region.

The swelling in the region of the hip is most striking in extracapsular fractures. Pain and functional disturbances are naturally more pronounced in unimpacted fractures than in impacted fracture. In the former, especially when extracapsular, active movement of the extremity is impossible, while in impacted fractures the patient can often raise his leg, stand upon it, and sometimes even walk.

The diagnosis of a fracture of the neck of the femur is not difficult, after what has been said, if a careful examination is made. The symptoms are least clearly marked in an impacted fracture. Here, above all, are all unnecessary movements of the leg to be avoided. One should therefore not examine the patient under an anæsthetic, lest the impaction should in some way be broken up during the excitement stage of the narcosis. In unimpacted fractures one can determine whether the case is one of intracapsular or extracapsular fracture chiefly from the amount of shortening and from the other symptoms mentioned above. If there is a marked shortening—e. g., of five centimetres—the case is surely one of extracapsular fracture. Fractures in the vicinity of the trochanter are very frequently both extracapsular and intracapsular, so that the above-mentioned symptoms are then correspondingly combined. The age of the patient is also important. Intracapsular fractures do not occur in individuals under fifty, extracapsular fractures not before twenty (Tubby), while separations of the epiphysis are observed on an average in persons between fourteen and fifteen.

The difference in the length of the legs is best measured with the pelvis straight and the legs parallel, from the anterior superior spine of the ilium to the joint line of the knee, or to the inner inferior or superior border of the patella, and from there to the tip of the internal malleolus. One may also, after Bryant, draw a transverse line from one anterior superior spine of the ilium to the other, and measure the distance of the top of the trochanter from this transverse line or from the anterior superior spine of the ilium on both sides.

For the differential diagnosis between fracture and dislocation, the reader is referred to the latter. The forward dislocations and the rare cases of eversion of the leg in iliac dislocations come especially under consideration. The fixation of the hip joint is especially characteristic of dislocation as well as the circumstance that the typical deformity can only be overcome by definite manipulation. In case of severe contusions of the hip, it often remains doubtful whether a fracture exists or not. One should, at all events, treat such cases as fractures. Finally, the age of the patient is important. If a person of advanced age has fallen upon the trochanter, the feet, or the knee, and if there is striking functional disturbance of the hip, the case is usually one of fracture of the neck of the femur.

As regards the prognosis of fractures of the neck of the femur, bony union

is most likely to take place in case of impaction of the fragments. Bony union also results, as a rule, in unimpacted extracapsular fractures, whereas it seldom occurs in unimpacted intracapsular fractures, in consequence of the insufficient nourishment of the head and the defective development of the periosteum, and hence pseudarthrosis is the rule. The nearer the fracture of the neck lies to the head of the femur the less often does bony union ensue. If bony union does not take place in an intracapsular fracture, the atrophic fractured ends are either united by fibrous tissue or no connection whatever ensues between the two fragments. The head of the bone may atrophy increasingly in consequence of the pressure of the neck, may be hollowed into an articular cavity, or may wholly disappear from pressure.

In all fractures of the neck of the femur in which bony union does not take place the use of the involved leg is very much impaired. The patient can walk only by the help of a cane or with crutches.

The time required for the bony union of a fracture of the neck of the femur is from six to ten weeks. Some shortening of the leg always remains, amounting, in favourable cases, to two or three centimetres. The difference in length is easily compensated for, partly by inclination of the pelvis and partly by the use, if necessary, of an elevated sole, so that the patient can walk without limping very noticeably.

Every fracture of the neck of the femur among aged people should be regarded as an injury not unattended with danger to life. In consequence of remaining in bed so long, such persons not infrequently die of hypostatic pneumonia, or of bedsores and their consequences. Sudden death from fat embolism has also been observed. The attempt should therefore be made, by proper treatment, to shorten as far as possible the confinement of aged patients to their beds.

Treatment of Fractures of the Neck of the Femur.—In non-impacted fractures one should, to begin with, overcome the existing deformity by traction and inward rotation of the leg. An extension splint is then employed, with the leg as much abducted as possible (see Principles of Surgery, page 224 ff.). In treating adults, a weight of from six to ten kilogrammes is used. A heavy weight must be used for patients with powerful muscles, as otherwise not enough effect is produced. If the foot of the bed is elevated, the weight of the body acts as counter-extension, or the latter may be applied by means of India-rubber tubing about the sound hip and proper weights at the head of the bed. A treadle, a wooden box, or the like, is placed at the foot of the bed as a support for the sound leg.

Extension of the leg while suspended—e. g., by means of a suspension splint (splint of plaster of Paris and hemp, after Schönborn-Beely), which is laid upon the anterior surface of the extremity when enveloped with a flannel bandage (Fig. 789)—is very serviceable. The suspension rings in the splint must be placed somewhat to the inner side of the middle line, in order that the leg may remain in its normal,

somewhat everted position. This combined suspension and extension allows the patient to move in bed and sit up without any injury to the fracture.

In impacted fractures everything depends upon the maintenance of the impaction, and all unnecessary movements are therefore to be avoided. It would be better to allow the femur to unite when slightly shortened and everted than to break up the impaction by overcoming this deformity. It is often sufficient in impacted fractures to place the leg in a Bonnet's wire cuirass (see Principles of Surgery, Fig. 172, page 205). A plaster splint which includes the pelvis and the whole leg may be used in order to allow the patient to move about. If an extension splint is used in impacted fractures, but little weight should be employed.

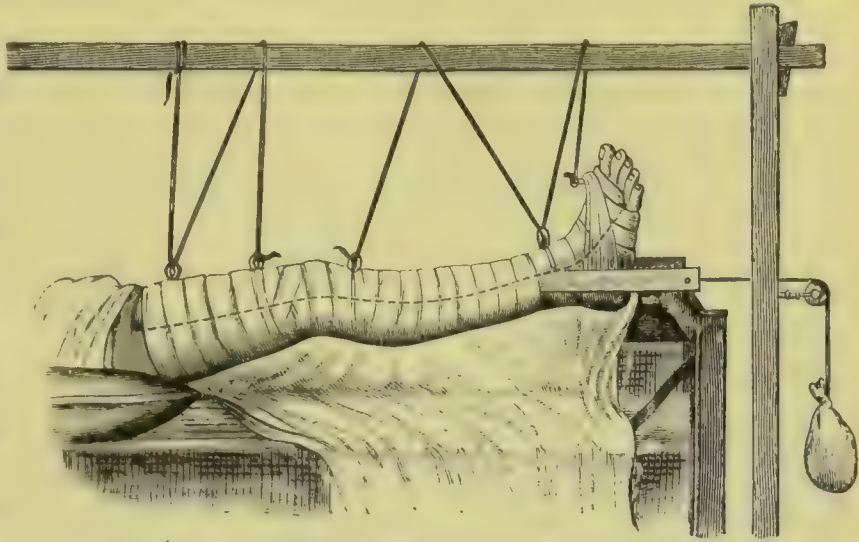


FIG. 789.—Extension of the leg in a suspended position.

Senn recommends, both in impacted and unimpacted fractures, after reduction and coaptation of the fragments, a plaster-of-Paris splint which includes the entire injured leg, and the sound one to the knee, the pelvis, and the abdomen, as far as the free border of the ribs, and which is strengthened by wooden splints. Pressure is exerted upon the fragments in the longitudinal direction of the neck of the femur by an outer splint of iron provided with clasps. Patients can assume any desired position with this dressing, and can be carried easily into the open air.

Aside from local treatment of the fracture, one must consider the general condition of the patient, particularly when of advanced age. Above all, the development of bedsores is to be prevented by cleanliness, rubbing with alcohol, placing the patient upon an air cushion or water cushion, upon a good hair mattress, upon the elevating frame of Volkmann and Hamilton (see vol. ii, § 140, page 775, Fig. 376), etc. In order to avoid hypostatic pneumonia among aged persons, one allows them to take more of a sitting position in bed. For the same reason old and feeble persons are allowed to leave the bed as soon as possible—after two weeks, for example, or less—and to walk about with crutches,

in a suitable splint. In such cases one may utilize for extension the weight of the extremity itself, and have the patient walk about in a Taylor extension apparatus (see Fig. 802, page 717), or with an elevated sole under the sound foot with fixation of the injured leg by means of a Thomas splint, or finally in a plaster spica with a foot-piece.

The effort has been made of late in fresh cases and in those in which there has been no bony union of the fracture, and which are attended with great disability, to unite the fragments by long ivory pegs, aseptic nails or long, pointed screws, or pegs of steel (Trendelenburg). In case of pseudarthrosis attended with marked disability, one may also open the joint under aseptic precautions, freshen the fragments and unite them by suture with silver wire. As a last resort the head of the femur may be removed under aseptic methods, as König, for example, has done with success.

Isolated fracture of the great trochanter occurs but rarely, and is caused usually by the action of direct violence upon the same, particularly among young persons. We have probably to do, in the latter, with separation of the epiphysis of the trochanter. Morris collected six such cases from literature. The trochanter, when broken off, is usually drawn upward, five or six centimetres, for example, by the *glutæus medius* and the *glutæus minimus* muscles. If the periosteum and the aponeurotic covering of the trochanter are intact, it is not displaced. Crepitus is to be felt, especially by flexion, abduction, and rotation of the thigh, with simultaneous pressure upon the trochanter. If there is no displacement of the trochanter, bony union ensues. If, however, there is displacement of the fragment, pseudarthrosis usually follows.

The treatment in case of displacement of the trochanter consists in fixation of the fragment in its normal place by means of an aseptic nail. If there is no displacement, placing the leg in a position of abduction and outward rotation, with slight flexion of the hip and the knee, is sufficient.

Gunshot Fractures of the Hip are always to be regarded as severe injuries. Gunshot injuries of the capsule alone are rare. The head of the femur and the acetabulum are usually injured at the same time—e. g., in the form of a groove or a hole or severe comminution of the head and of the socket. The ball often remains in the head or in the acetabulum. Associated injuries of the vessels, the nerves, and the pelvic organs are especially important for the prognosis, particularly those of the bladder and the intestine. The joint is most likely to be struck by shots from in front—e. g., four centimetres below the anterior superior spine of the ilium (Langenbeck). Slight injuries may heal without special disturbance, particularly simple gunshot injuries of the capsule. There usually ensues, however, severe septic inflammation, especially in gunshot injuries of the bone, if antiseptic treatment is not begun with sufficient promptness. After such inflammation, serious impairment of mobility or complete ankylosis usually remain.

The location of the wound and the position of the entrance and exit openings are of special importance for the diagnosis of injury to the joint, which

may be difficult immediately after the infliction of the wound. In case of shattering of the head and neck of the femur, the symptoms of a fracture of the neck of the same are present. The effusion of blood in the joint may lead to such a distention of the capsule that the femoral artery is distinctly lifted forward.

The treatment of a gunshot wound of the hip joint, like that of every compound fracture of a joint, must be strictly antiseptic. When it is settled beyond question that a gunshot wound of the joint exists, one will open the latter freely, remove the separated splinters of bone and foreign bodies (ball, etc.), resect, it may be, the shattered head of the bone, and drain the joint. Disinfection and drainage of the joint are sufficient in gunshot injuries of the capsule alone. In case suppuration of the joint already exists, resection of the head of the femur through the trochanter is necessary in order to give room for sufficient drainage. In doubtful cases one may either await the further course or follow the advice of Langenbeck, König, and others, and enlarge the entrance and exit openings sufficiently to determine whether or not and to what extent the joint is injured. In war practice, at all events, the expectant treatment is to be recommended. Bergmann and Reyher used the expectant method of treatment with brilliant success in the Russo-Turkish War, confining themselves to disinfection of the wound and its surroundings, and then immobilizing the extremity by means of a plaster-of-Paris splint. Healing by primary union often ensued, the ball remaining in the tissues. In other cases suppuration followed, which was then treated by resection and drainage of the joint.

Bending of the neck of the femur is occasionally observed among children or young persons from fifteen to eighteen years of age, resulting, for example, from earlier osteomyelitis from which the patient has recovered, from rickets, or from carrying too heavy loads in the developing period. Flexion of the thigh is but slightly restricted, but its abduction and rotation more so. Patients complain of pain in walking, and usually limp somewhat. The neck of the femur is lengthened and so bent that the head lies beneath the tip of the trochanter; it is, moreover, turned on its long axis (Kocher). The trochanter may be displaced upward two or three centimetres. The angle between the neck and the shaft of the femur is correspondingly changed. The inner structure of the bone undergoes a change answering to the alteration in the distribution of the weight supported (E. Müller, J. Schulz). The cancellous tissue may be softened, especially at the lower circumference of the head and neck.

The legs of otherwise healthy individuals are seldom of equal length, slight differences being the rule. This inequality may give rise to scoliosis, or spinal irritation (Martin).

§ 319. **Inflammations of the Hip.**—The different forms of inflammation described in *Principles of Surgery*, page 658 ff, especially acute and chronic serous effusion, and acute and chronic suppuration, are observed in the hip as in every other joint. Acute suppurative inflammation of the hip may arise from wounds of the joint, in the course of acute infectious diseases (measles, scarlet fever, smallpox, typhoid

fever), from acute osteomyelitis of the femur, etc. Among chronic inflammations of the hip, tubercular disease and arthritis deformans (*malum senile*) especially interest us. We must speak of both more in detail, on account of their great practical importance. The local symptoms of acute inflammations of the hip are similar to those attending tubercular disease. For the treatment of these acute inflammations the reader is referred to *Principles of Surgery*, page 664 ff.

Tubercular disease of the hip (*morbus coxæ*) is most frequently observed between the fifth and the tenth year. It seldom occurs before the third year, or among adults of any age.

Etiology and Pathology.—Tuberculosis of the hip most frequently arises primarily in the bone, and the focus, which is found in the head of the femur, in its neck or in the trochanter, then breaks through into the joint and leads to a tubercular arthritis (Figs. 790, 791). Primary disease of the synovial membrane is much more rare. In the further development of the tubercular process one can distinguish in the synovial membrane three different forms, which, to be sure, usually merge into one another: 1. The pure miliary form.



FIG. 790.—Infarct-shaped tubercular focus in the head of the femur which has become distinctly demarcated. The joint cartilage is elevated by the underlying pus. Early resection (Volkman).



FIG. 791.—Tuberculosis of the neck of the femur with three sequestra. Secondary tuberculous of the hip joint with destruction of the joint cartilage.

2. The fungous form, with abundant formation of fungous granulation tissue.
 3. The fibrous form, with circumscribed thickenings of the membrane. There is often found in the joint at first a serous or sero-fibrinous exudation and later cheesy pus. The cartilage and the bone are more and more destroyed by the progressive tubercular disease, the head of the bone and its neck may completely disappear in consequence of the tubercular infiltration, and the acetabulum is not infrequently perforated. The articular cavity is very often enlarged in an upward direction in consequence of progressive erosion of the acetabular rim, and the head of the bone follows (intra-acetabular luxation). After the tubercular inflammation of the joint breaks through the capsule, very large abscesses sometimes ensue. Extra-articular tubercular abscesses

also arise from the transportation of tubercle bacilli by means of the lymph passages, no continuous connection between the articular and the periarticular processes being demonstrable. The abscesses very often break through the skin spontaneously, so that long fistulous tracts result. Tubercular hip disease may heal at any stage, but the cure is often only temporary, and recurrences follow. Children very often die of general tubercular infection (tuberculosis of the lungs, tubercular meningitis, tubercular enteritis, or general miliary tuberculosis).

The tubercular foci in the trochanter and the neck of the femur not infrequently break through externally without involving the joint (Fig. 792).

The clinical course of hip disease in childhood is usually very chronic, and may be divided into four different stages: 1. The initial stage. 2. The first stage of the active process, with changed position of the extremity (usually flexion, abduction, and eversion with increased [secondary] inclination of the pelvis and apparent or real lengthening of the leg). 3. The second stage of the active process, with adduction, inversion, and flexion of the hip, and apparent or real shortening of the leg. 4. Termination of the coxitis; spontaneous cure with or without restriction of movement or ankylosis, cure as the result of an operation, or death from tuberculosis of the internal organs, especially the lungs, from general miliary tuberculosis, etc.

The initial stage of coxitis is usually characterized by two symptoms—a limping gait and pain in the hip, the entire femur, and the knee. The first thing that is noticeable is that the child quickly tires after walking and favours his leg—that is, he limps. At the very beginning of the disease regular symptoms of inflammation are not demonstrable at the hip, because the primary focus of disease is located in the head or the neck of the femur and the hip joint itself is still free. The rarer cases of primary synovial disease form an exception. In the further course of the initial stage, the second symptom, the pain becomes more and more prominent. The hip joint is painful in walking, when pressure is made against the trochanter and upon the front of the joint, and also when it is moved. There is often very severe pain at night. The children frequently complain of pain in the knee joint, so that the latter is erroneously looked upon by the laity as the seat of the disease. This pain in the knee, which frequently, in fact generally, occurs in connection with hip disease, is explained in very different ways. It is probably conditioned upon the fact that the tuber-

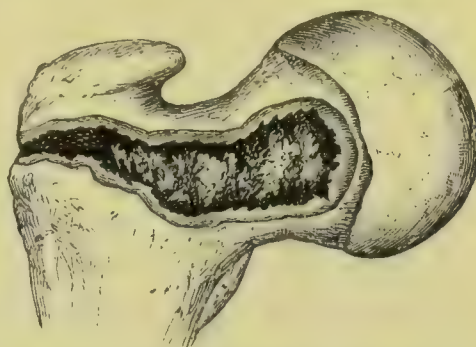


FIG. 792.—Extra-articular rupture of a tubercular focus in the neck of the femur (Volkmann).

cular osteomyelitis in the upper end or the neck of the femur occasions an irritation of all the nerves of the entire medullary cavity as far as the lower epiphysis of the femur. These nerve irritations are added together in the latter and are here felt as pain. According to the views of other authors, the pain in the knee is caused by irritation of the obturator nerve.

Simultaneously with this increasing painfulness of the hip the same becomes more and more fixed and immovable. Rotation especially is first interfered with, and then the range of the other movements of the hip is restricted. The mobility of the joint is only apparently interfered with in the first stage—that is, the patient holds the joint stiff by means of his muscles. If he is anæsthetized, it is found that the passive mobility of the joint is disturbed but very little if at all.

With the appearance of the diminished mobility of the hip joint begins the first stage of the active process, and the extremity now assumes a very characteristic position—that is, the leg is flexed at the hip, is abducted and rotated outward.

In order to be able to use the leg, which is in so abnormal a posture, for walking and standing, the patient inclines the pelvis forward and lowers it toward the diseased side so that there ensue lordosis of the lumbar segment of the spine, lateral curvature (scoliosis) of the dorsal segment, and apparent lengthening of the leg. Actual lengthening may occur also in

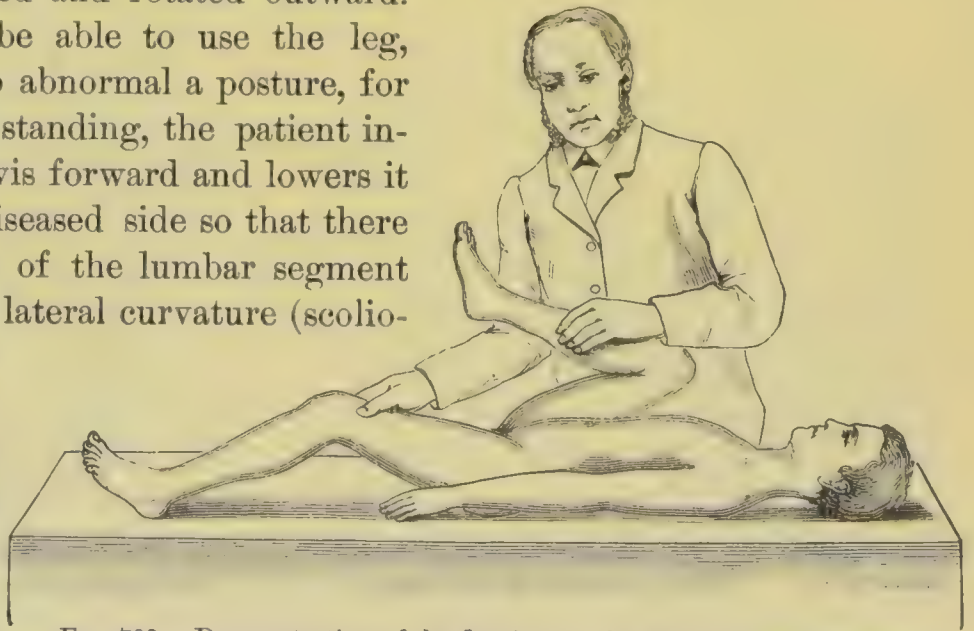


FIG. 793.—Demonstration of the fixation of the left hip joint in coxitis.

consequence of increased growth due to the inflammatory irritation. The active and passive movements of the hip are now really restricted, rotation in particular, but the other movements as well (flexion, extension, abduction, and adduction). The fixation of the leg or of the pelvis can be very well demonstrated by placing the patient in a horizontal posture, flexing the sound leg as completely as possible, and then attempting to extend the diseased leg (Fig. 793). The pelvis is at once raised, and the vertebral column arches forward correspondingly, as in lordosis. The movements of the hip are found to be restricted also when the patient is under an anæsthetic.

Why does the leg assume in hip disease a position of flexion, abduction, and outward rotation? Bonnet showed that in this position the hip joint has the greatest capacity. By artificial distention of the hip joint one produces exactly the same position of the leg as that just given. In tubercular disease, however, there is usually no maximum distention of the joint from serous or suppurative effusion to cause this typical posture, but it is rather the patient himself who voluntarily and instinctively chooses that position of the joint in which the latter is least burdened—that is, is free from pain and has the greatest capacity, in order that the inflamed articular surfaces may be subjected to the least possible pressure. In my opinion, we have to do essentially with a reflex contracture conditioned upon the inflammatory irritation within the hip joint as in all inflammatory articular contractures.

In the further course of tubercular hip disease all the objective and subjective symptoms become more marked. There is increased swelling in the region of the hip joint, the leg becomes more and more atrophied in consequence of the disuse of its muscles, and the pain reaches such a degree that walking and standing become impossible, and the child is obliged to lie in bed. The position of the diseased leg now changes. The flexion usually increases in case of unsuitable treatment, but the outward rotation and abduction gradually pass more and more into inward rotation and adduction, because the child now in

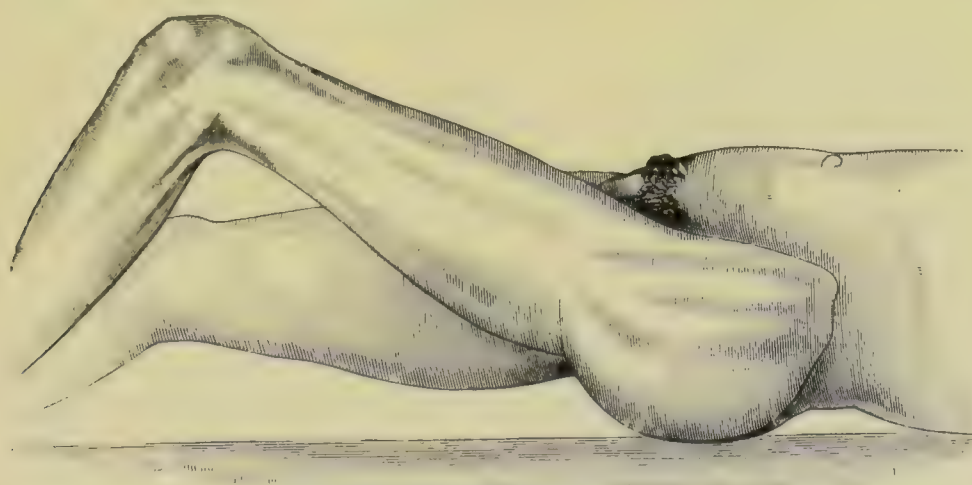


FIG. 794.—Contracture of the hip joint in coxitis in consequence of shrinkage of the fascia lata.

lying supports his diseased leg against the sound one. The contracture of the hip then becomes more and more fixed in consequence of shrinkage of the muscles and the fascia lata (Fig. 794). One notices, in addition, a shortening of the leg, which becomes more and more distinct. This is at first only apparent in consequence of the oblique position of the pelvis, but it then becomes more and more real—e. g., from tuber-

cular destruction of the head or the neck of the femur, from arrest of development owing to tubercular degeneration of the epiphyseal line, from inflammatory separation of the head of the femur in the epiphyseal



FIG. 795.—Pathological dislocation of the head of the femur in coxitis.

line, enlargement of the acetabulum from erosion of the acetabular rim, and finally from dislocation of the head. The latter is essentially a destruction dislocation produced by the changed form of the head and neck of the femur due to caries. It is rare, because the inflammatory fixation of the joint and the periarticular soft parts is usually too great. The movement of the head of the femur in following the enlargement of the socket in an upward and backward direction which results from erosion of the ace-

tabulum is to be distinguished from this rare dislocation of the femur. In both conditions the trochanter is situated above Nélaton's line, and the two have often been confused.

In the further course the tubercular inflammation of the hip extends more and more, in part continuously and in part non-continuously, by means of the lymph passages. Periarticular abscesses and fistulæ are formed, the iliac bursa becomes involved, etc. The acetabulum is very frequently and sometimes very early attacked by caries. The caries then progresses more and more, and the tubercular inflammation not infrequently breaks through the acetabulum and the pelvis and leads to tubercular disease of the pelvic organs, especially of the bladder, with the formation of urinary fistulæ. The pus very often appears above Poupart's ligament and sometimes in the neighbourhood of the rectum. In case of perforation of the acetabulum, examination by rectum is important, as one can palpate the region of the acetabulum and gain definite knowledge as to the existence of any complicating inflammation of the pelvic cavity.

In the last stage of coxitis there results, after years usually, either a spontaneous cure or cure as the result of an operation, or, finally, death from increasing exhaustion, from tuberculosis of the internal organs, especially the lungs, from general miliary tuberculosis, etc. The beginning of the last stage varies greatly. It depends very essentially upon the character of the treatment and the constitution of the patient.

The course is not always so typical as we have briefly described it.

Exceptions are very common. Cases are sometimes observed with a very acute course, in which death—e. g., from general miliary tuberculosis or tubercular meningitis—ensues in a few weeks with rapid destruction of the joint. The latter sometimes takes place very early, especially in primary synovial tuberculosis and in case of superficially located foci in the bone.

Diagnosis of Hip Disease.—Confusion is most likely to occur with inflammations in the neighbourhood of the hip joint, especially with psoas abscess following tubercular spondylitis, and with tubercular inflammation of the large bursa situated between the tendon of the glutæus maximus muscle and the trochanter. There is the same flexion of the thigh in both the latter as in the first stage of hip disease in consequence of inflammatory contracture of the ilio-psoas or the glutæus muscle. One should therefore examine the spine in every case of suspected hip disease. In both inflammations that have been named the hip joint is without pain, and examination under an anæsthetic shows that the disturbance in mobility, the contracture, does not have its seat in the hip joint itself. Suppuration beginning in the large gluteo-trochanteric bursa, which is from four to six centimetres long and from two to four broad, may easily spread beneath the glutæus maximus or the tensor fasciæ latæ and in the direction of the quadriceps muscle. In doubtful cases the question will have to be settled by opening up the existing fistulous tracts.

Tubercular hip disease may sometimes be confused, among adults as well as among children, with the so called hysterical joint. It is characteristic of the latter that even after years there is entire absence of inflammatory swelling or destruction of the joint. In very rare cases, finally, neoplasms in the vicinity of the hip joint or the neck of the femur have given rise to confusion with morbus coxæ.

In every case of hip disease one should, by an examination under an anæsthetic, secure as exact an idea as possible as to the existence of crepitus, caries, etc.

The prognosis of hip disease is not favourable. According to Billroth, the mortality amounts to 28½ per cent, and according to Bruns, about 40 per cent. The earliest possible adoption of a suitable treatment is very important, and a cure is often effected in the initial stage. A cure may result in any stage of the disease. If, however, the disease has passed into the second stage of the active process, and extensive caries already exists, the prognosis is usually unfavourable. In spite of energetic treatment by means of an operation, one frequently loses such patients in consequence of tuberculosis of the lungs or tubercular meningitis, etc. The prognosis is furthermore made worse by the appearance of suppuration and with the increasing age of the patient. Of the non-suppurative form, 77 per cent were cured, and of the suppurative and fungous form only 42 per cent. The latter result can undoubtedly be much improved by iodoform treatment. The first decade shows 65 per cent cures, the second 56 per cent, the third and fourth only 28 per cent, and the fifth none. The cure is very frequently not permanent. Even after from ten to twenty years, recurrences have been seen to occur. Fistulæ long since cicatrized break open again, and the coxitis, from which there was apparent re-

covery years before, reappears with renewed severity either spontaneously or after an injury, and may now lead with comparative rapidity to death from tuberculosis. All this is now intelligible because we know the power of resistance and the tenacity of life possessed by the spores of tubercle bacilli. If a cure results, complete return to the normal may ensue in rare cases without any functional disturbance of the hip joint, in case the disease has not progressed beyond the initial stage. If, on the other hand, the coxitis is distinctly developed, there usually remain permanent functional disturbances, especially shortening of the leg and more or less restriction of movement. Contractures of the hip are always to be avoided by proper treatment; and if they exist, they are to be overcome subsequently, as far as possible, by subtrochanteric osteotomy or resection of the femur (see § 321, pages 723, 724, Contracture of the Hip Joint).

Death results in tubercular hip disease in about forty per cent of the cases (Bruns), after an average duration of three years, usually from tuberculosis of other organs, especially the lungs and meninges, from acute general miliary tuberculosis, from amyloid degeneration of the viscera, and sometimes very quickly from pyæmia and septicæmia.

Treatment of Hip Disease.—The treatment of tubercular hip disease is at the outset conservative. Bruns has shown, on a basis of two hun-

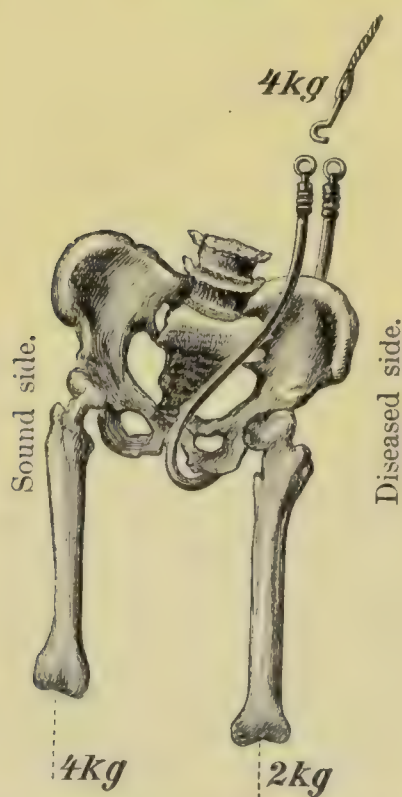


FIG. 796.—Extension in case of abduction of the leg with apparent lengthening of the same from lowering the pelvis on the diseased side.

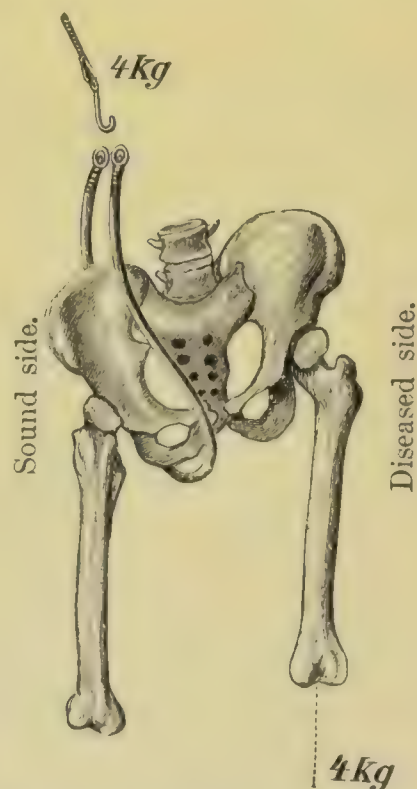


FIG. 797.—Extension in case of adduction of the leg with apparent shortening of the same from lowering the pelvis on the sound side.

dred cases, that under conservative treatment fifty-five per cent of the cases are cured with an average duration of the disease of four years. Rosmanit and Thausing have published similar results

from Billroth's clinic. In the initial stage the diseased joint is to be immobilized as far as possible, and its use in walking and standing is to be strictly prohibited. The patient must lie in bed, and the joint is fixed in a suitable position by the application of an extension apparatus (see *Principles of Surgery*, page 224 ff.). Weights of from two to five kilogrammes are used for children, varying according to their age, and five or six kilogrammes or more for adults. This extension takes the pressure off of the articular surfaces and permits a small space between the two. In order to overcome or to prevent the inclination of the pelvis and the flexion of the thigh, the pelvis must be elevated by placing a pillow beneath it. In case of extreme abduction of the thigh in the first stage of coxitis it is a good plan to apply extension to the sound leg also, but with heavier weights (Fig. 796), and to use counter-extension on the diseased side. In adduction contracture in the second stage of coxitis—e. g., with apparent shortening of the leg in consequence of obliquity of the pelvis—extension on the diseased leg with counter-extension on the sound side is sufficient (Fig. 797).

If one desires to have the patient move about, a plaster-of-Paris spica and the foot piece may be used (Fig. 819, page 733).

The fixation of the hip joint by Thomas's method is very useful. It has the advantage that the patient can take exercise in the open air. The splint is made of soft iron and consists of an upright bar for the posterior region of the buttocks and leg and bands of hoop iron which encircle the chest, the pelvic region, and the thigh close under the trochanter, also the region of the knee and the leg. The splint is to be bent at a proper angle in the region of the buttock. It is fastened on with bandages. In order that the patient may be able to walk about with crutches, the foot of the sound side is provided with an elevated sole, so that the diseased leg swings freely (Fig. 799). Heusner uses the splint represented in Figs. 800 and 801 with good success. The patient can walk about in this (see fuller description in *Verhandlungen der deutschen Gesellschaft für Chirurgie*, Twentieth Congress, 1891). Since this splint has come into use, Heusner also has given up more and more resection of the hip joint and has performed it only exceptionally. Upholstered cases which can accommodate the whole body of the patient with outspread legs are very useful in

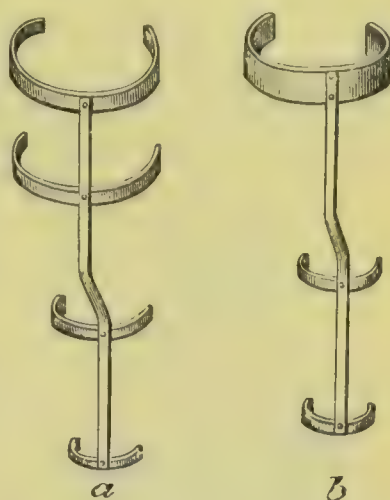


FIG. 798.—Thomas's splints for immobilization of the hip.

treating small children. They are similar to Ollier's apparatus (*lit-gouttière*). The patient is firmly buckled in such a case, and can easily be carried about and brought into the fresh air.

Other local treatment is of a symptomatic character. Ice is often serviceable if there is much pain. I attach great importance to the earliest possible intra-articular and periarticular injection of sterilized ten-per-cent iodoform oil or iodoform-glycerin, about four or five grammes of the mixtures named (more for adults) every two to four

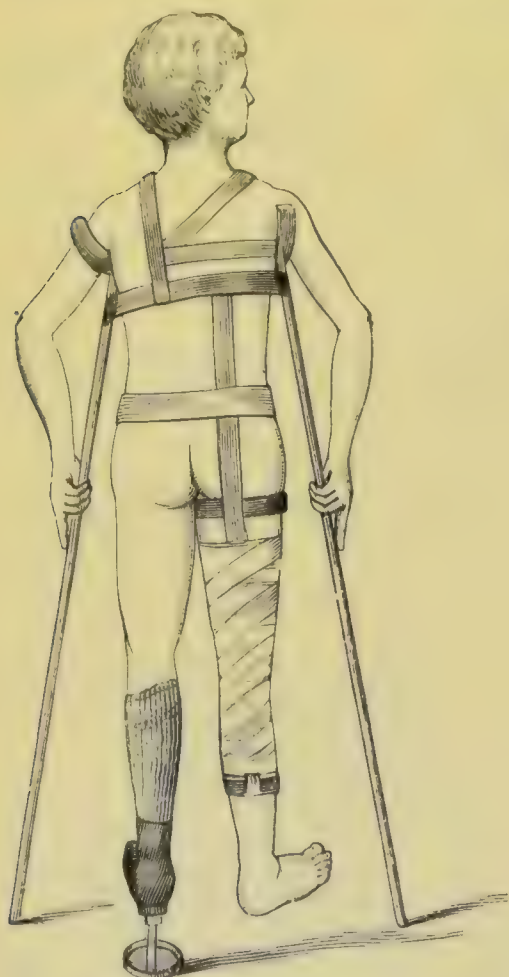


FIG. 799.—Immobilization of the hip in coxitis on the right side.



FIG. 800.—Heusner's splint for coxitis.

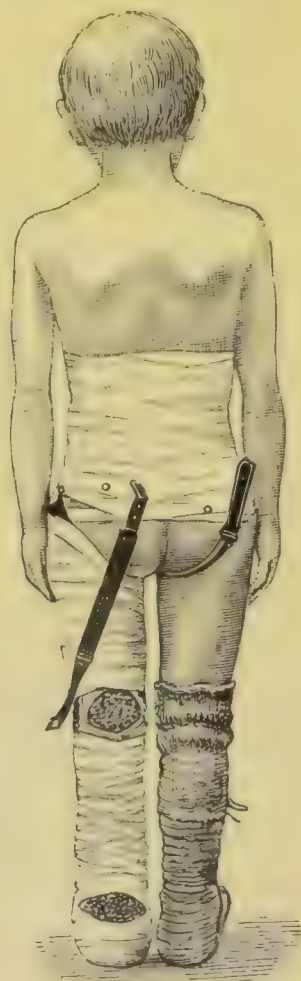


FIG. 801.—Preceding splint applied.

weeks. The injections are made with the patient under an anæsthetic, and preferably by puncture above the trochanter with the thigh in flexion and abduction. The hip joint is most surely reached at this point. After the injection into and about the joint, passive movements are made, and careful massage, so as to distribute the iodoform as well as possible in and about the joint. I also, as well as P. Bruns, Krause, and others, have seen very surprising results, and I share the belief that iodoform is really an antitubercular remedy of the highest rank.

Besides the local treatment, a general strengthening treatment

(nourishing food, good air, brine baths, sea baths, etc.) is of the greatest importance.

If no improvement follows the treatment which has thus far been recommended, the question arises whether a conservative treatment is to be continued or resort shall be had to an operation. This decision is often difficult, and the views of different surgeons are widely divergent in this matter. The principle, however, applies to the hip joint also that typical resections are to be restricted as far as possible, and that they shall not be performed too early, because incurable deformity is the result of extensive resection. We should very frequently content ourselves with opening the joint and scraping it out. We preserve all that is possible of the bone. Resection is indicated, however, in cases where there are marked suppuration and destruction of the joint, also in case of high fever or suppuration that endangers life, likewise in case of pathological dislocation, etc. In case of amyloid degeneration of the abdominal viscera that has not progressed too far, the only means of saving the patient often lies in the adoption of an energetic treatment by operation. The question whether the head of the femur alone, or its neck as well, is to be removed depends upon the nature of the case or the extent of the disease.

FIG. 802.—Taylor's extension splint for coxitis.

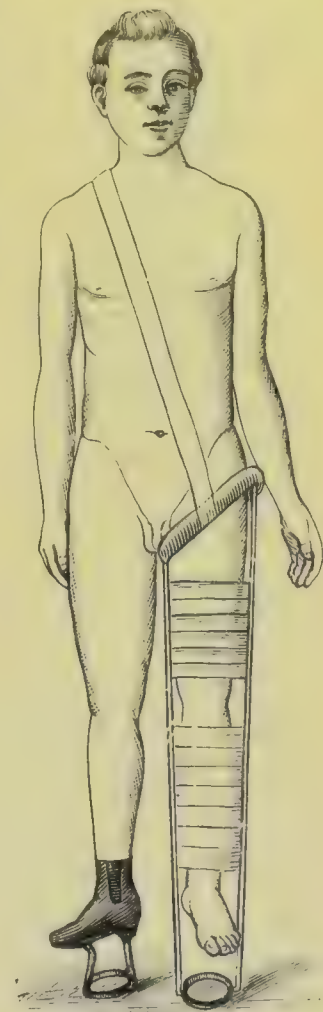


FIG. 803.—Thomas's splint with a support for the tuberosity of the ischium and a raised sole for the sound foot.

Volkman resected by preference through or below the trochanter. It is no doubt true that drainage of the joint is facilitated by resection of both head and neck; but if the external wound is left open and packed with iodoform gauze, one can just as well preserve the neck of the femur, and the functional results are certainly better when it is preserved. After the resection of the diseased portion of the femur the synovial membrane is thor-

oughly removed with scissors and forceps, the acetabulum is examined, scraped out if necessary, etc. Bardenheuer and Hans Schmidt proposed and performed resection of the diseased socket. The functional result in Bardenheuer's case was a good one. Healing usually takes place with ankylosis. I always pack the wound with iodoform gauze. After the application of an antiseptic protective dressing extension is employed with the thigh abducted and the pelvis elevated. The counter-indications to resection are usually the general condition of the patient, tuberculosis of the lungs, tuberculosis of the intestines, etc. (For the technique of resection of the femur, see § 326, page 743.)

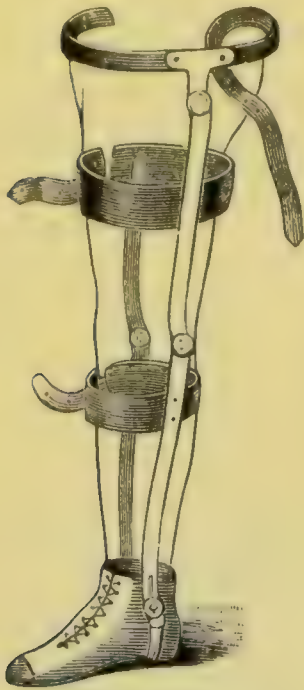


FIG. 804.—Brace for the lower extremity with pelvic belt.

Rough manipulation should be avoided in performing resection. Death from miliary tuberculosis has not infrequently been seen to occur after resection of the femur.

Periarticular abscesses are to be treated, in accordance with general rules, by incision, scraping out, and drainage, which it is best to supplement by the injection of ten-per-cent iodoform-glycerin or iodoform oil.

During the period of healing of hip disease extension should be continued for a long time—e. g., at night, by means of a gaiter buckled about the leg. If it is desired to apply extension when the patient is walking or to support the leg—e. g., after arthrotomy or after resection of the hip joint—one can utilize Taylor's extension apparatus (Fig. 802), Thomas's splint (Fig. 803, and Fig. 799, page 716), some form of brace such as the one shown in Fig. 804, or a portable plaster-of-Paris or water-glass splint.

Fistulæ or other recurrences are treated, according to general rules, by scraping with the sharp spoon, and, above all, by the injection of iodoform emulsion. The patient must be carefully watched for a long time, and great importance is to be attached to strengthening the constitution by good food, brine baths, sea baths, residence in a southern climate, etc.

§ 320. **Other Inflammations of the Hip.**—Suppurative, non-tubercular arthritis of the hip is observed in the course of various infectious diseases, particularly measles, scarlet fever, smallpox, typhoid fever, pyæmia, septicæmia, etc. The suppuration is not always very marked. We have sometimes to do only with a serous effusion, which may lead

to spontaneous dislocation (see § 317, page 697). Suppurative effusions occasionally occur also in the course of acute articular rheumatism and in gonorrhœa. The latter are mostly catarrhal inflammations, but in exceptional cases they go on to severe and destructive suppuration. Acute septic inflammations of the joint are sometimes observed in the course of acute osteomyelitis of the pelvis or the femur. Suppurative inflammations of the hip joint with a subacute course also occur in childhood and youth, in consequence of acute osteomyelitis of the upper end of the femur. Separation of the epiphysis often takes place in these suppurative inflammations of the hip joint following acute osteomyelitis. Furthermore, abscesses in the vicinity of the hip joint may rupture into the latter and cause suppurative arthritis.

The clinical course of the subacute and more chronic suppurative inflammations is essentially the same as that described above for tubercular hip disease. Generally speaking, however, the contracture of the hip is not so typical here as in the tubercular disease in childhood. All acute suppurative inflammations of the joint are characterized, above all, by very painful inflammatory swelling and high fever. The diagnosis of the different forms of inflammation is based upon a thorough local examination and upon the history of the patient. The prognosis depends essentially upon the cause of the suppuration and upon prompt and energetic local treatment.

The treatment of subacute and chronic arthritis of the hip is similar to that of tubercular disease, with the exception only that one must here make speedy provision for the discharge of the pus and drainage of the joint by arthrotomy or by resection of the femur, especially in case of high fever, in order that further injurious effects of the suppuration may be checked. In cases of catarrhal inflammation of the joint without fever one can try injections of ten-per-cent iodoform-glycerin or iodoform oil, three-per-cent carbolic acid, etc. In case of acute septic arthritis, resection of the joint is to be performed as soon as possible, in order to save the patient from septicæmia. Serous effusions are treated by massage and methodical exercise of the joint.

Hysterical Hip Disease.—Neuralgia of the Hip.—This form of inflammation, first described by Brodie, is observed especially among females with irritable weakness of the nervous system or pronounced hysteria, particularly among young girls of the better classes. The affection is sometimes found also among perfectly sound persons, both male and female. Injuries, colds, or nervous shocks are often the determining cause. Reflex neuralgia of the hip joint also occurs in connection with diseases of the abdominal viscera and of the female sexual organs, and likewise in connection with diseases of the central nervous system, especially tabes.

The principal symptom of hysterical hip disease is the pronounced painfulness of the joint without definite and demonstrable anatomical changes. The patient keeps the hip joint stiff on account of pain. Muscular spasms are sometimes observed, as well as perverse contractures of the hip and ankle, vasomotor disturbances of the skin, tremor, extreme weakness and atrophy of the leg, and sometimes pronounced paralysis. When the patient is under an anæsthetic the contractures disappear and the hip joint is freely movable. The course is usually very prolonged and variable. A cure ensues suddenly sometimes, especially in case the nervous system is otherwise sound, after a nervous shock or after a vigorous movement of the hip. In case of pronounced hysteria and disease of the nervous system the patient is sometimes condemned to a sick-bed for years and the affection may be incurable. Sprains of the hip with intra-articular adhesions or contraction of the capsule are most likely to be confused with neuralgia of the hip. These are most quickly cured by massage and systematic exercise of the joint.



FIG. 805.—Atrophic form of arthritis deformans of the hip. (Pathological collection in Zurich.) The neck of the femur is no longer present and the head has sunk below the top of the great trochanter.



FIG. 806.—Hypertrophic form of arthritis deformans of the hip. The neck of the femur has disappeared and hence the head is close to the great trochanter. (Pathological collection in Leipsic.)

The treatment of nervous coxitis is directed chiefly against its cause, hence against the existing hysteria and any diseases of the internal organs (sexual diseases, constipation, etc.). A general tonic treatment of the nervous system (cold-water treatment, sea baths, elevated health resorts, separation of the patient from the family and from his occupation) is strongly to be recommended. The local treatment consists in massage, systematic exercise of the joint, and in the use of electricity (strong faradic or galvanic currents transversely through the hip joint). Quinine, iron, and arsenic are given internally, and morphine and atropine are sometimes administered hypodermically. Contractures of the leg are prevented by suitable splints.

For other forms of neuralgia of the hip joint, see also Principles of Surgery, page 603.

Arthritis Deformans of the Hip is a disease of advanced age. It never leads to suppuration or caries, but to gradually increasing deformity of the joint, especially of the head and neck of the femur, both from degenerative and from hyperplastic processes in the cartilage, the bone, and the soft parts. The hyaline articular cartilage is destroyed through fibrillation, softening, and splitting, so that the bone itself is finally exposed, which then takes on a smoothly polished surface in consequence of the movements of the joint. Hand in hand with these degenerative changes proliferation of cartilage is observed, especially on the free parts of the articular surfaces, in the form of nodular protuberances, which usually ossify later. The bone itself is likewise the seat both of degenerative processes, atrophy of the bone, and of bone formation. The neck of the femur may completely disappear by absorption (Figs. 805 and 806). An atrophic form of arthritis deformans (Fig. 805) and a hypertrophic form (Fig. 806) may be distinguished, according as the atrophy or the hypertrophy of the cartilage and the bone is the more prominent. The capsule and the articular ligaments finally become thickened and contracted. There are sometimes free bodies in the joint (see Principles of Surgery, page 687). The hip joint becomes more and more deformed in consequence of the changes that have been described in the head of the femur and the thickening and contraction of the capsule. The mobility of the joint either diminishes constantly, or, in case atrophy of the bone predominates, it is increased—that is, the joint becomes flail-like. In the latter case partial or complete dislocations (deformation dislocations) may ensue. The permanent reduction of these dislocations is usually impossible, in consequence of the deformation of the head of the femur and the acetabulum. The head of the bone then forms for itself a new socket—e. g., on the ilium (Fig. 807). Arthritis deformans is either confined to the hip joint or it may occur simultaneously in other joints. It is to be regarded as essentially a senile disturbance, and occurs sometimes spontaneously and sometimes after a determining cause.

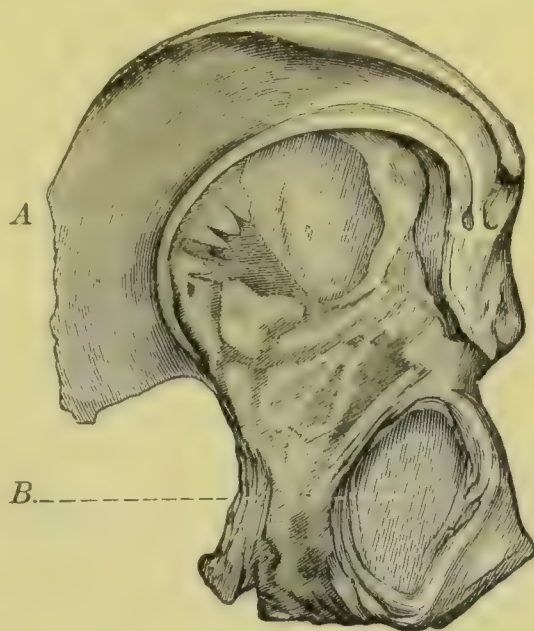


FIG. 807.—Formation of a new acetabulum (*A*) on the ilium after dislocation of the femur due to arthritis deformans; *B*, remnant of the original acetabulum (Gutsch).

The clinical course of arthritis deformans of the hip is extremely

chronic. At its outset it is characterized by stiffness of the joint, especially in the morning, by pain in walking, and by crepitant or crackling sounds. In the further course the deformation of the joint, the diminished mobility, or, on the other hand, the loose condition of the hip, become prominent. A cure is very rare, and the disease usually grows progressively worse.

The treatment consists in very early use of massage and systematic movements of the joint (mechanical apparatus may be used for the purpose), in the employment of hydropathic remedies and baths (lukewarm tub-baths, sand-baths, mud- and steam-baths, cold douches), and also in the use of hot springs (Gastein, Wildbad, Wiesbaden, Teplitz, etc.). Residence in southern climates is very beneficial, as is a general strengthening regimen (good food, etc.). Resort to an operation in order to overcome any functional disturbances is usually not indicated, in view of the age of the patients. A proper splint is used in case of dislocation of the head of the femur or a loose joint.

§ 321. **Contracture and Anchylosis of the Hip.**—Contracture and an-
chylosis of the hip often result from chronic inflammations of the



FIG. 808.—Extreme contracture of both hips in a position of abduction and flexion (Busch).

joint, and one frequently sees defective positions of the joint in consequence of unsuitable treatment. The contracture of the hip in a definite posture, with corresponding restriction of its mobility, is conditioned usually upon contraction of the periarticular soft parts, particularly of the superficial and deep aponeuroses, and of that part of the fascia lata which extends from the crest of the ilium to the upper and outer side of the thigh, also upon contraction of the ilio-femoral ligament and the muscles—e. g., the psoas muscle, the tensor fasciæ latæ, the rectus femoris, and the adductors (see Fig. 794, page 711).

In case of complete immobility of the joint or anchylosis proper, we have to do, as a rule, with fibrous, cartilaginous, or bony union of the head of the femur with the acetabulum.

If an immovable hip joint is in a good position, so that the leg can be used for walking and standing, the patient complains at the most of some inconvenience in sitting and in rising. Anchylosis of a hip joint can to a certain degree be compensated for by increased mobility of the pelvic articulations and of the connection between the sacrum and the

spine ; and the contracture—e. g., a flexion contracture—can be somewhat counterbalanced by tilting of the pelvis and lordosis of the spine. If, on the contrary, the leg is in an unfavourable position—e. g., in one of flexion, abduction, or adduction—walking and standing may be so interfered with thereby as to create a necessity for relief, especially in case of contracture of both hip joints, as in Fig. 808.

The Treatment of Contracture and Anchylosis of the Hip Joint.—Mild cases of contracture are overcome gradually by the use of weight-extension apparatus, combined, in flexion contracture, with simultaneous elevation of the pelvis upon a pillow. If the purpose is not accomplished in this way, forcible correction of the unfavourable position of the leg (*brisement forcé* of the French), with the patient under an anæsthetic, is to be recommended. This may be performed in one or several sittings, and care must be exercised, of course, not to fracture the neck of the femur. Moreover, a new and acute outbreak of an old tubercular process may result from forcible correction of the deformity. In the same way acute suppuration of the joint has been observed after correction of ankylosis and contracture of the hip joint caused by an osteomyelitis that had apparently healed. The microbes encapsulated in the tissue become free again in consequence of the passive movements, and find a favourable medium for growth in the extravasated blood. One should, therefore, not undertake forcible correction of the contracture as long as there are still fistulæ. If the contracture has been overcome by gradual extension or forcible correction, one should then attempt to aid the mobility of the hip, when healthy, by massage, baths, the use of electricity, and active and passive movements. If passive movements prove very painful, they may at times be performed under an anæsthetic.

If it is impossible to improve the unfavourable position of the joint in a subcutaneous way by means of the treatment thus far described, one should then, in suitable cases, resort to an operation. The subcutaneous or open division of the tense soft parts, particularly the fascia lata, the ilio-psoas muscle, the adductors, and the tensor fasciæ latæ, is often sufficient. One may also, after Winiwarter, divide the skin, the contracted fascia, and, if necessary, the muscles also, by means of a V-shaped incision on the anterior outer aspect of the thigh from Poupert's ligament downward. The wound is then united so as to form a Y-shaped line of suture. If necessary, one may also perform linear intertrochanteric osteotomy. After the deformity has been corrected a weight-extension apparatus is applied.

Lauenstein cured a contracture of the adductors from a central cause by division of the obturator nerve. The nerve is found beneath the fascia of

the obturator externus muscle, and the best way is to make a longitudinal incision beginning at the outer side of the spine of the os pubis and extending down the anterior aspect of the thigh. After the fascia lata has been divided, and the outer border of the adductor longus muscle exposed, the pectineus muscle, which is situated to the outer side of the latter, is slit with a blunt instrument in the direction of its fibres, and after the thin fascia of the obturator externus, which now lies exposed, has been divided, the nerve is sufficiently accessible and can be drawn forward by means of a silk suture and cut.

Cuneiform osteotomy, which is best performed below the trochanter—e. g., for flexion contractures and adduction contractures—is a very useful operation. The trochanter is exposed by a longitudinal incision on its posterior and outer side, the periosteum with the soft parts is pushed to one side for about two thirds of the circumference of the bone with a periosteal elevator, and a wedge answering to the flexion contracture and adduction contracture is chiselled from the bone, at first with a gouge and then with a straight chisel. Simple linear division of the bone is often sufficient. The bone may also be partially divided and then the rest broken through with the hands. Any tense bands of tissue or abnormal adhesions can finally be divided subcutaneously. After the unfavourable position of the joint has been corrected a weight-extension apparatus is applied, and this is best done with the thigh in abduction, whereby a constant inclination of the pelvis and a correction of the shortening are effected simultaneously.

The deformity caused by ankylosis can be improved by resection of the femur, and one can sometimes by this means secure a movable joint. Resection of the femur is indicated especially in case of ankylosis of both hip joints and in those cases in which the inflammation of the ankylosed joint has not yet completely subsided. Of late, resection of the femur has also been repeatedly performed in place of subtrochanteric osteotomy for ankylosis and contracture of one hip only. König, for example, has completely given up cuneiform osteotomy in cases of ankylosis with abduction and flexion, and has substituted resection. In cases of pure adduction contracture and of extreme atrophy of the shortened extremity one should always, however, as König also has emphatically stated, choose cuneiform osteotomy in preference to resection. Resection of the femur for ankylosis of the hip is performed in the following manner: After the joint has been exposed by means of a posterior trochanter incision the neck of the femur is divided with a chisel, and then, in case of bony ankylosis, the head is chiselled out of the socket, whereby the acetabulum can easily be perforated. Sufficient bone is to be resected from the femur to allow complete correction, and it may be necessary to chisel away

the trochanter at the same time. Here also an extension apparatus is subsequently applied until healing takes place. This is done with the thigh in abduction and a heavy weight is used (five to ten kilogrammes, according to the nature of the case and the age of the patient). To prevent recurrence, one should afterward make use of extension, at night especially, by means of a gaiter applied to the lower extremity.

§ 322. **Injuries of the Soft Parts of the Thigh.**—In case of injury of the large arteries and veins of the thigh as well as elsewhere, the wounded vessel must be tied in the wound both proximally and distally with the aid of an Esmarch bandage. All branches going off from the wounded part of the vessel must likewise be tied. The wounded portion of the vessel—e. g., of the femoral artery—is finally extirpated and the external wound is drained and closed by suture or packed with iodoform gauze. If the femoral artery and vein are both injured, as, for example, in a case upon which I operated, both must be tied in the same way. In case of partial division of the artery, which is often overlooked, secondary hæmorrhages easily occur. These partial divisions are characterized by harsh blowing sounds upon auscultation at the place of injury, which are synchronous with the pulse (Wahl). They are propagated on both sides of the vessel, but particularly in the direction of the blood current. According to W. Braune, gangrene of the lower extremity is much to be feared after ligation of the femoral vein, because the establishment of the collateral circulation in the veins is rendered difficult in consequence of the arrangement of the valves. Braun, Bergmann, and the author have shown, however, that, especially since the adoption of aseptic methods in surgery, the femoral vein has been ligated comparatively often below Poupart's ligament without the occurrence of gangrene of the lower extremity. Ligation of the vein alone is entirely without danger, and it is only in case of ligation of both artery and vein that gangrene is to be feared. Out of twenty-eight cases of ligation of the femoral vein at Poupart's ligament collected by Kammerer, only two resulted in gangrene; and of thirty-five cases collected by Niebergall, there was only one case of gangrene. On the other hand, out of twenty-two cases of ligation of both artery and vein collected by Kammerer, gangrene resulted twelve times; and of twenty-four cases collected by Niebergall, gangrene occurred fourteen times. It is of special importance that ligation be performed under aseptic precautions, in order to prevent extensive thrombosis. After contusions in the subinguinal region with thrombosis of the femoral vessels extensive gangrene easily develops, so that after it has become demarcated amputation is necessary. Vertical suspension of the extremity is to be recommended during the

after-treatment, in order that the circulation may be improved, and, above all, that the venous flow on the posterior surface of the lower extremity may be free. The resistance offered by the valves of the collateral veins (circumflex iliac, obturator, etc.) seems to be different in each case, but at all events it is best overcome by vertical suspension.



FIG. 809.—Ligation of the femoral artery.

One can, moreover, arrest hæmorrhage from the femoral vein by suture of the adventitia with catgut (Schede), likewise by compression or packing the wound, and, finally, by ligation of the femoral artery, by which the *vis a tergo* and the blood current are so diminished that the hæmorrhage from the vein is arrested. The most trustworthy remedy in cases of hæmorrhage from the femoral vein is ligation in the wound, both proximally and distally, from the wound in the vessel. Death from entrance of air into the opened femoral vein has not as yet been observed. This occurs, as is well known, only in venous wounds near the heart.

Ligation of the Femoral Artery.—The femoral artery runs approximately in a line connecting the middle of Poupart's ligament with the posterior circumference of the inner condyle of the femur (Fig. 809). At the lower third of the thigh, before the artery passes through the adductor canal, it lies close to the outer border of the sartorius muscle, where the above-mentioned line is met by a second line running about from the external inguinal ring to the inner condyle of the femur (Fig. 809).

Ligation of the Femoral Artery just below Poupart's Ligament.—The skin incision, which is from six to eight centimetres in length, begins two centimetres above the middle of Poupart's ligament, and descends in the direction of a line running to the posterior circumference of the inner condyle of the femur. After dividing the superficial fascia and the fat, and pushing to one side or extirpating any lymph glands, the fascia lata is split upon a grooved director. The vessel sheath is opened about one centimetre below Poupart's ligament, whereby the circumflex iliac artery which goes off directly below Poupart's ligament and the inferior epigastric artery are to be avoided. The femoral vein lies to the inner side of the artery, and to the outer side in the lacuna musculorum lies the anterior crural nerve. It does not come into view if the incision is made correctly.

Ligation of the Femoral Artery in Scarpa's Triangle.—The base of Scarpa's triangle is formed by Poupart's ligament, and the sides by the sartorius and adductor longus muscles. This tissue cleft can always be distinctly felt. The skin incision, which is six to eight centimetres long, begins five or six finger breadths below Poupart's ligament, and runs in the direction of the above-mentioned line, along the inner border of the sartorius muscle. After the inner border of the sartorius muscle has been exposed it is retracted outward. The posterior wall of the sartorius sheath or the fascia lata is then carefully divided upon the grooved director, whereupon the femoral vessels immediately appear. In opening the vessel sheath the long saphenous nerve, which runs over it, is to be avoided. The femoral vein lies to the inner side and somewhat behind the artery. They are rather firmly united at this place, and the isolation of the artery and passage of the aneurismal needle about it require, therefore, some caution.

The profunda artery sometimes arises from the external iliac.

Ligation of the Femoral Artery before its Passage through the Adductor Canal.—The thigh is flexed, abducted, and rotated outward. The inner border of the sartorius muscle is then felt for, then the outer border of the muscle, and an incision made here, parallel to the latter, from six to eight centimetres long, which runs about in a line drawn from the external inguinal ring to the inner condyle of the femur (Fig. 809). The outer border of the sartorius muscle is exposed and drawn downward and inward by means of a retractor. A broad aponeurotic band now becomes visible, which passes from the adductor magnus to the vastus internus muscle. After this band has been divided the artery appears. The long saphenous nerve, which lies upon it, first comes into view, and this serves as a guide. The vein lies behind the artery, and is here likewise firmly united with the latter, so that the isolation of the artery should be undertaken with the greatest caution.

Ligation of the femoral artery in the above-named locality, which has just been described, has special interest in connection with military surgery, because it has frequently been found necessary to ligate the very hidden wounded artery at this point for secondary hæmorrhage—e. g., on the eighth or ninth day after the injury.

The same rules apply, generally speaking, for ligation of the femoral vein that have been given for that of the artery. The vein lies to the inner side of the artery in the upper part of the thigh and behind it in the region of the adductor canal. With reference to the dangers and the after-treatment of ligation of the femoral vein, see page 725.

The same rules apply to the treatment of wounds of the nerves in

the thigh (anterior crural and great sciatic nerves) that we have described in detail in connection with wounds of the nerves of the upper extremity. The reader is therefore referred to § 295.

Hernia of Muscle means the protrusion of a portion of a muscle through an unhealed rent in the overlying fascia, or in the sheath of the muscle in question (Fig. 810). Such a hernia affects most frequently the rectus muscles



FIG. 810.—Hernia of the adductor longus muscle through a rent in the fascia caused by a fall from a horse (Rawitz).

of the abdomen and the muscles of the thigh, especially among cavalry and artillery soldiers. The rupture of the fascia or of the sheath either occurs suddenly—e. g., from a fall, as in Fig. 810—or more gradually, and a corresponding portion of the muscle then protrudes more and more as an elastic, fluctuating swelling. Should the hernia cause much pain, one may cure it by an operation consisting in incision of the skin, freshening the rent in the sheath or the fascia, and closing the same with catgut. In case of patients who are afraid of the knife, one may make use of an elastic girdle with a pad. The patient should also wear this for some time after an operation.

Rupture of the quadriceps tendon above the patella has been observed repeatedly. It was first described by Ruysch. Démarquay collected a large number of cases from literature. Sometimes, especially when there is degeneration of the substance of the muscle, the rupture takes place in ordinary walking, without the occurrence of any special violence. The rupture is usually attended by an audible sound. There is a distinct depression above the patella and an extravasation of blood. Active extension of the leg is impossible. The ends of the tendon are to be united by aseptic suture.

Rupture of the ligamentum patellæ is very rare. In case of complete rupture the patella may be displaced upward. The tendon is sometimes torn off at its insertion on the tuberosity of the tibia, with or without avulsion of a portion of the latter. In case the tuberosity is torn away, it should be fixed in its normal place by suture or an aseptic nail. Simple rupture of the ligamentum patellæ is treated by suture with catgut.

§ 323. **Fractures of the Shaft of the Femur.**—The shaft of the femur is fractured most frequently in its middle third and less often in its upper than in its lower third. The fracture occurs at every age, but is especially common among children. It arises sometimes from direct and sometimes from indirect violence, such as a fall upon the feet or the knee. The indirect fractures are either flexion fractures, when the bone is bent beyond the limit of its elasticity, or torsion fractures, the line of fracture taking a spiral course (Fig. 811). In the latter variety the bone is twisted by violent muscular action—e. g., by a kick

which misses its aim, or in the case of a person who suddenly turns his body in order, for instance, to escape an injury. The line of fracture is most frequently more or less oblique, less often transverse. If the line of fracture is very oblique, the fracture is likely to become compound—that is, the sharp fragment pierces the skin. The so-called longitudinal fractures of the femur are, as a rule, oblique fractures with an almost vertical course. They occur most commonly at the lower end of the femur. Multiple and comminuted fractures also occur. Incomplete or “green-stick” fractures of the femur are, generally speaking, rare, as are isolated fissures (Fig. 812). The latter more frequently occur simultaneously with complete fractures, especially with gunshot fractures, and they may then penetrate into the hip joint



FIG. 811.—Spiral fracture of the femur (Koch).



FIG. 812.—Fissures of the femur.



FIG. 813.—Oblique fracture of the lower third of the femur with a longitudinal fracture extending into the knee joint (Gurlt).

or the knee joint (Fig. 813). The displacement is usually considerable. Its character depends upon the direction in which the violence acts, upon the location of the fracture, and upon the traction of the muscles. Thus, in fractures of the upper third of the femur, the upper fragment follows the traction of the ilio-psoas and the gluteal muscles, while the lower fragment is drawn inward by the adductors. In fractures

of the middle third of the femur the upper fragment almost always lies in front of the lower one, likewise in fractures of the lower third. In the latter the upper fragment is displaced inward, moreover, by the adductors, while the lower fragment deviates in the direction of the popliteal space from the action of the gastrocnemii muscles. In all fractures of the femur the lower fragment, in consequence of the weight of the extremity, is rotated on its long axis and usually in an outward direction.



FIG. 814.—Fracture of the shaft of the femur.

The symptoms of fracture of the thigh are usually so distinct that the diagnosis can be made easily. The deformity arising from the above-described displacement of the fragments is, as a rule, very striking. The leg is usually everted, so that it rests upon its outer surface. It can not be raised or otherwise moved, and is distinctly shortened (Fig. 814). The shortening is especially marked in oblique fractures. It may amount to from ten to twelve centimetres. Crepitus and abnormal mobility are easily made out, especially by traction and rotation. In rare cases impaction of the fragments occurs. The diagnosis is then, of course, not so easy. The principal symptom in such cases is the shortening of the leg. The same is true of the rare "green-stick" fractures among rhachitic children. They are characterized by pain at the site of the fracture, bending of the bone, and an effusion of blood.

The prognosis of fractures of the femur is favourable, also that of compound fractures if they are treated under antiseptic precautions. Permanent shortening of the thigh is likely to remain after oblique fractures and those which have united with deformity. It was formerly doubted whether it was possible to secure union of fractures of the thigh among adults without shortening. With the help of improved methods of treatment, however, especially extension, it is undoubtedly possible to bring about union even of oblique fractures without shortening. Of one hundred and ten fractures of the thigh treated by extension, eighty-seven united without any shortening whatever, and in the remaining cases the shortening amounted to from one half a centimetre to one centimetre (Volkmann). The time required for the union is from six to eight weeks for adults and from four to five weeks for children. Pseudarthrosis is most likely to take place when soft parts are interposed between the ends of the fragments and when the latter override. The prognosis is unfavourably affected by injury of the vessels or nerves, by penetrating wounds of the hip joint and knee joint, and by malunion

resulting from unsuitable treatment. Corresponding functional disturbances may then remain. Among old people life may be endangered by hypostatic pneumonia and bedsores. Death has sometimes occurred from fat embolism.

Treatment of Fractures of the Thigh.—In case of marked swelling the leg may be placed for the first few days upon a double inclined plane, in Heister's case (Principles of Surgery, Fig. 167, page 203), in Bonnet's wire splint (see Principles of Surgery, Fig. 172, page 205), or in Pott's lateral position. In the latter case the leg lies on its outer side, with the hip joint and knee joint in flexion, and is retained in this posture by means of sand bags. Temporary plaster-of-Paris splints or wood splints—e. g., as shown in Fig. 815—are useful for transporting the patient. The plaster-of-Paris splint is applied about the pelvis and the extremity after an abundant use of wadding, while the buttocks rest upon a pelvic support (see Principles of Surgery, Fig. 117, page 172). Any displacement is overcome by extension.

As a permanent splint the weight-extension apparatus (see Principles of Surgery, page 225) is by far the best. Any displacement is carefully to be overcome, and the extremity must be so placed in an extended posture that the great toe or the long axis of its metatarsal bone, the inner border of the patella, and the anterior superior spine of the ilium are in the same line. The weight to be used varies from two to eight kilogrammes, according to the age of the patient. A chaff pillow is placed beneath the knee, in order that it may not be overextended. The ends of the fragments may be fixed by means of a short plaster-of-Paris splint, or a lateral splint on the outer side of the extremity, but this is usually unnecessary. One often fails to overcome the displacement completely by simple extension, and must then—e. g., in case of abduction of the upper fragment—employ extension with the thigh abducted; or, in case of marked flexion of the upper fragment, combine extension with suspension by applying, for example, a splint of plaster of Paris and hemp (Fig. 816), or Smith's telegraph-wire splint (see Principles of Surgery, Fig. 207, page 225), to the front of the leg, which is slightly flexed at the hip and enveloped in a flannel bandage. Vertical suspension with a plaster-of-Paris splint, with the knee joint bent at right angles, as shown in Fig. 817, may also be em-

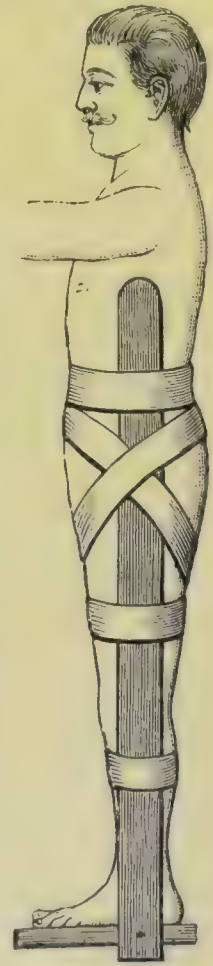


FIG. 815.—Temporary splint for the transportation of a patient with fracture of the femur.

ployed. Bardenheuer, in addition to longitudinal extension, makes use also of transverse and rotation extension. In case of marked angular deformity of the leg, he has the longitudinal extension act not in

the longitudinal axis of the thigh, but toward the convex side.

In the case of little children vertical extension, after Schede, is a very convenient method (Fig. 818). An extension splint is first applied in the ordinary way (see Prin-

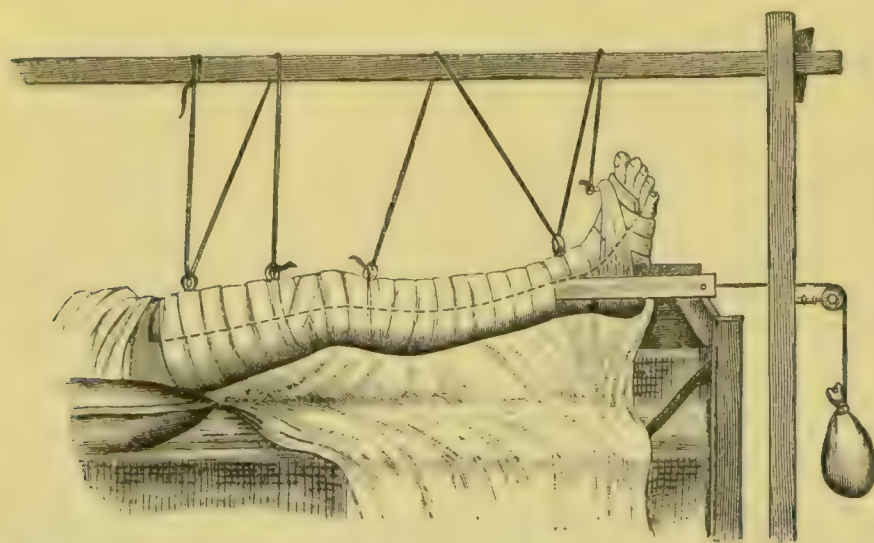


FIG. 816.—Extension combined with suspension by means of a splint of plaster and hemp or telegraph wire for fractures of the femur.

ciples of Surgery, page 225), and the leg is then extended in a vertical posture so that the gluteal region swings free of the bed. A weight of from two to four kilogrammes is sufficient.

Fractures of the thigh are treated in England by means usually of Liston's or Desault's long external splint. The wooden splint reaches beyond the foot and the pelvis, and is fastened by bandages to the extremity, which is first enveloped in flannel bandages. One may also apply a short splint on the inner side of the thigh for further support of the site of fracture. The

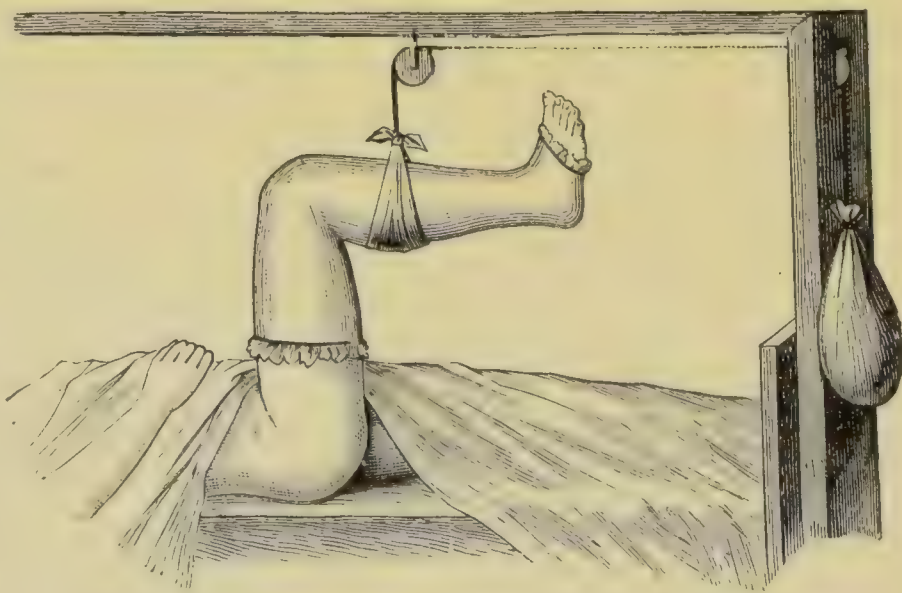


FIG. 817.—Vertical suspension combined with a plaster splint.

results are very good. One can also combine with this external splint extension and counter-extension in the usual way, or by means of an elastic India-rubber tubing at the lower end of the splint.

Following the suggestion of Hessing, who was the first successfully to employ ambulatory apparatus for fractures of the leg, surgeons have of late treated simple and compound fractures of the lower extremity more and more, and with favourable results, with the patient walking about (Dombrowski, Reyher, Bardeleben, Harbordt, Heusner, Korsch, P. Bruns). This method of treatment, moreover, was recommended by Bérard as early as 1833. The time required for the union of the fracture is shortened in this way, and the injurious influence of confinement in bed upon the general health is avoided. The patient remains in bed at the outset for

from six to ten days, for example, with the leg extended, after which ambulatory splints are used. Thomas's splint is represented in Figs. 798 and 799, page 715. Some surgeons use plaster - of - Paris splints, which include the whole

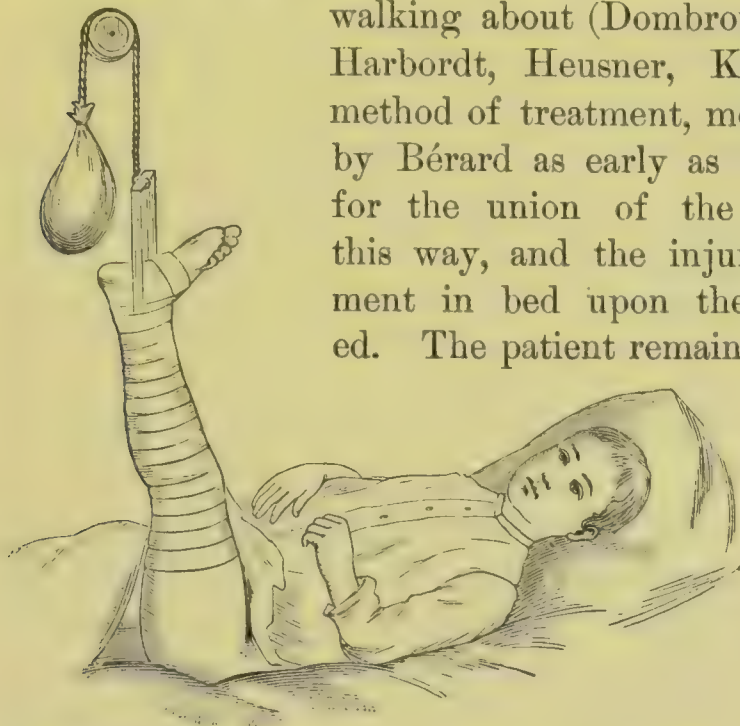


FIG. 818.—Vertical suspension for fractures of the femur in children.

extremity and pelvis, and produce some extension. Harbordt, Heusner, P. Bruns, Liermann, and others have recommended special ambulatory splints (see *Die med. Wochenschrift*, 1889, No. 37, and 1890, No. 38).

Compound fractures of the thigh are treated under antiseptic precautions and according to general rules (see *Principles of Surgery*, page 597 ff. and 732 ff.).

Fractures of the thigh which have united with deformity, causing functional disturbances, are improved either by refracturing the bone subcutaneously at the site of fracture with the hand or an osteoclast (see *Principles of Surgery*, Fig. 74, page 84), or by linear or cuneiform osteotomy with the hammer and chisel, after the bone has been exposed by incision of the soft parts—e. g., in case of angular posture of the extremity—on the convex side. In cuneiform osteotomy the base of the wedge answers to the apex of the angle made by the fragments. In performing osteotomy I use large, broad, and narrow chisels

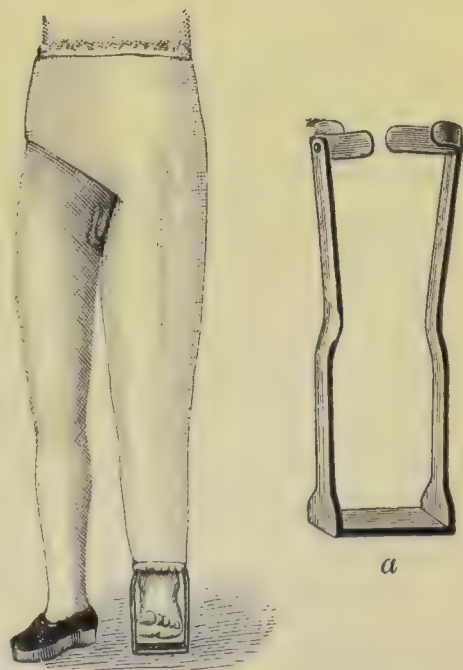


FIG. 819.—Plaster spica with an iron foot piece (a).

alternately. The undivided portion of the bone is broken with the hands. Simple linear division is usually sufficient. I leave the wound in the soft parts open, apply an antiseptic bandage, and then extension with the thigh in a normal posture, with or without a plaster-of-Paris splint about the fracture, or an apparatus such as is represented in Fig. 816 or 818. One will, in suitable cases—e. g., in cases of long standing among children and young persons who have not attained their growth—make a suitable division of the contracted soft parts, especially of the muscles, as Lorenz did, with good results. Marked shortening—resulting, for example, from displacement of the fragments, has likewise been overcome by osteotomy with the subsequent use of an extension apparatus with a considerable weight (twenty to thirty pounds, Schede, the author).

In case of a fresh callus one may often overcome the deformity, especially among children, for example, by simply bending the extremity straight.

For the treatment of pseudarthrosis the reader is referred to Principles of Surgery, page 591.

§ 324. **Inflammatory Processes and other Diseases of the Thigh.**—The acute inflammatory processes, circumscribed abscesses, and deep inter-muscular phlegmons are described in Principles of Surgery, page 331. The deep subfascial suppurations are opened by a skin incision in the longitudinal direction of the extremity, and a closed dressing forceps or artery clamp is pushed into the abscess, careful attention being paid thereby to the course of the large vessels and nerves.

Inflammation of the inguinal glands (bubo) has already been spoken of on page 378 in connection with soft chancre. For the non-suppurative indolent buboes attending syphilis the reader is referred to § 84 of Principles of Surgery. They usually give no occasion for local treatment.

Other inflammations of the inguinal glands—e. g., suppurative inflammations—are observed especially after wounds of the lower extremity that are not treated aseptically. The original injury is often a very insignificant one. Tubercular inflammations of the inguinal glands also occur.

The different forms of bubo are treated in the manner described on page 380. Elephantiasis and chronic œdema of the lower extremity sometimes follow the complete extirpation of inflamed inguinal glands (Riedel).

We have already spoken of the course and treatment of psoas abscesses in vol. ii, § 146, page 815, and in § 263, page 485. They are almost always conditioned upon tubercular spondylitis.

Sciatica.—By sciatica is understood a neuralgia along the course of the sciatic nerve. The pain is sometimes very severe and may extend to the calf of the leg and the heel. There are usually definite points that

are painful on pressure, especially at the place of exit of the sciatic nerve from the great sacro-sciatic notch of the pelvis and in the region of the spine of the ischium, also on the posterior aspect of the thigh and in advanced cases beneath the head of the fibula and beneath and behind the internal malleolus. Sciatica is due essentially to an acute inflammation of the sheath of the sciatic nerve resulting from various causes, the most frequent of which is "catching cold." In the further course, especially when the extremity is kept quiet continuously, there develop thickenings and inflammatory adhesions of the sheath of the nerve with the surroundings. These are in the later stages the principal cause of the pain. After long continuance of sciatica the movement of the leg in question becomes more and more interfered with in consequence of the pain—particularly those movements by which the inflamed and swollen nerve sheath is compressed or stretched. The patient carefully avoids these movements, and it is therefore easy to understand that after a time temporary contracture of the thigh sometimes develops with obliquity of the pelvis and lateral curvature (scoliosis) of the lumbar and dorsal segments of the spine. The patient maintains the leg and the pelvis in that position in which the sciatic nerve is most relaxed. These contractures almost always disappear very quickly under suitable treatment.

The best treatment for sciatica, judging from my own experience, is the earliest possible use of massage and active and passive movements of the leg. Even in chronic cases which had already lasted for months, and in which the patients could scarcely walk or stand, I have been able to secure a permanent cure in from two to four weeks by the use of massage and by passive movements and methodical exercise. An anæsthetic is sometimes necessary in the first sitting, on account of the great pain. In these passive movements one should also stretch the sciatic nerve—that is, flex the leg as completely as possible at the hip, with the knee joint extended. The inflammatory adhesions of the sheath of the nerve with the surroundings are hereby loosened and stretched, and they are, in fact, the principal cause of the pain. The patient must walk as much as possible, and diligently make active movements with the hip and the knee, as well as with the spine. Massage and passive and active movements are combined, it may be, with baths and electricity. The use of hot springs (Gastein, Teplitz, Ragatz, etc.) is also very salutary. I have seen no special success attend the use of medicinal remedies, whether given internally or administered subcutaneously. I have repeatedly stretched the sciatic nerve after exposing it by a posterior incision in the worst cases of sciatica, and in two cases with excellent success. I scarcely make use of it, how-

ever, any longer, as I have always accomplished the purpose by the use of massage and the subcutaneous method of stretching.

Stretching the Sciatic Nerve.—The nerve stretching introduced by Billroth and Nussbaum has been performed with varying success on the sciatic nerve in treating the following affections:

1. Disturbances of nerve activity (paresis, neuralgia) in consequence of adhesion of the sciatic nerve or its sheath with the surrounding connective tissue after injuries (Nussbaum).

2. Traumatic affections of the spinal cord with tabetic symptoms (König, Riedel).

3. Many, though not as yet definitely defined, forms of tabes or of pseudo-tabes resulting from peripheral neuritis.

4. Different forms of neuritis, neuralgia, and typical sciatica.

I once saw decided improvement in a case of tabes from stretching the sciatic nerve. I also stretched the nerve with success not long ago for traumatic neuralgia and for mild paretic symptoms, because the

sheath of the nerve had become thickened and adherent with the surroundings after a gunshot wound received two years before.

If one can choose the place, the incision for stretching the sciatic nerve is made either in the gluteal fold or above the popliteal space between the biceps muscle on one side and the semimembranosus and semitendinosus on the other side.

When the nerve is stretched in the gluteal fold (Fig. 820) the patient lies upon his abdomen. The skin incision, which is about ten centimetres long, begins on a level with the tuberosity of the ischium

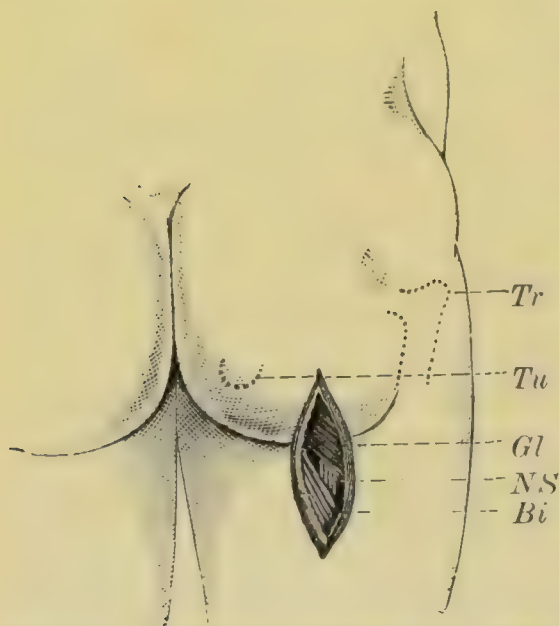


FIG. 820.—Incision for stretching the sciatic nerve: *Tr*, trochanter; *Tu*, tuberosity of the ischium; *Gl*, glutæus maximus; *NS*, sciatic nerve; *Bi*, biceps.

midway between the latter and the posterior edge of the great trochanter. After the skin, the thick cushion of fat, and the superficial fascia have been divided, the fibres of the glutæus magnus muscle appear in the upper corner of the wound running obliquely outward and downward, while the upper border of the biceps muscle becomes visible in the lower angle of the wound (Fig. 820). If the borders of the two muscles are drawn apart with retractors, the sciatic nerve appears deeper down. It is isolated as far as possible, without wounding the

sciatic artery which accompanies it, is drawn outward with the thumb and forefinger, after the nerve sheath has been opened, and stretched in both directions until it is distinctly lengthened. Then follow drainage, suture, and the application of an antiseptic dressing.

Above the popliteal space the nerve is easily found, after the skin, the cushion of fat, and the superficial fascia have been divided, between the semimembranosus and semitendinosus muscles on one side and the biceps muscle on the other side.

Aneurisms in the Thigh.—The different forms of aneurisms (see Principles of Surgery, page 532 ff.) are not uncommon in the thigh, and are observed especially after injuries. They are to be treated according to the rules described in detail in Principles of Surgery, page 537. The attempt should first be made to bring about coagulation in the sac by digital compression and compression by means of elastic bandages. The best way is to apply an elastic bandage for about an hour and a half, first enveloping the leg from below upward nearly to the aneurism with an India-rubber bandage, and then applying, just above the aneurism, an Esmarch tube, and removing the India-rubber bandage. The rubber tubing is allowed to remain for an hour or an hour and a half if possible, and digital compression is then made use of for from six to twelve hours. This treatment must be continued for a considerable time. The compression is often not endured. If it is impracticable or without effect, the treatment of the aneurism by an operation is to be recommended. This consists in splitting or extirpating the sac, after proximal and distal ligation of the artery and all branches that come off from the aneurism (Antyllus), or in proximal ligation (Anel, Hunter), or distal ligation (Wardrop, Brasdor), as we have described it in Principles of Surgery, page 538. The treatment of cirroid aneurism and arterio-venous aneurism may consist in extirpation with careful arrest of the hæmorrhage on all sides by ligation of the afferent and efferent vessels, or in the use of ignipuncture by means of the galvano-cautery or the fine point of a Paquelin cautery.

Riedel observed a peculiar circumscribed endarteritis of the femoral artery with gangrene of the leg. The artery was fully obstructed to the extent of two centimetres. Its lumen had been greatly constricted by circular proliferation of epithelium and then completely occluded by a thrombus.

Varicose Veins of the Thigh.—Varicose dilatations of the veins in the form of the well-known bluish, often sacciform tortuous swellings of the cutaneous veins, in consequence of engorgement and obstruction of the venous current, occur very frequently on the thigh, especially among women after repeated pregnancies. The varicose enlargement of the saphenous vein along its whole length, or in more circumscribed form at the saphenous opening, deserves special notice. Death from hæmorrhage has frequently re-

sulted from the rupture of a varicose vein. They are sometimes complicated by periphlebitic inflammation and suppuration—e. g., in case of eczema or ulcers of the skin, and also by extensive thrombosis. The so-called phleboliths arise when the thrombi become chalky and calcified. Varicose ulcers of the skin are very common, especially on the leg.

The treatment of varicose veins consists in enveloping the leg with a roller bandage, elastic bandage, or elastic stocking. Paul Vogt recommended cutaneous and subcutaneous injection of ergotin into the perivascular tissue (extract. secale cornut., 1-to-10 aqua destillata, 0·10 acid. carbol.). The solution is to be frequently renewed, and its decomposition is prevented by the addition of a little carbolic acid.

Varicose veins can furthermore be tied and excised. Ligation with catgut can also be performed without making an incision by passing a catgut ligature behind the vein with a curved needle and tying the ligature over a drainage-tube, for example. Recurrences frequently occur even after excision of the varicose portions. See also Varicose Veins of the Leg.

Dilatation of the lymphatic vessels of the thigh or the lower extremity (lymphangiectasis) occurs under much the same conditions as that of the veins, in consequence of obstruction of the lymph current. It is usually combined, after long standing, with hypertrophy of the skin and the subcutaneous cellular tissue (elephantiasis), which may become very marked. Not infrequently the varicose lymphatic vessels burst and a so-called lymphatic fistula results. The escape of lymph may be very marked.

For the different forms of elephantiasis, the reader is referred to Principles of Surgery.

The treatment of lymphangiectasis is, generally speaking, the same as that of enlargement of the veins, though, to be sure, it is often attended with meagre results. In many cases punctiform caustion—i. e., multiple punctures with the Paquelin cautery or the galvano-cautery—is serviceable. Successful extirpation may be very difficult because it is not easy to recognise the boundary between sound and diseased tissue. Lymphatic fistulæ have been cured by transverse division of the skin above the fistula. Elephantiasis may be treated by elastic bandages, repeated excision of spindle-shaped pieces of skin, and, above all, ligation of the femoral artery, by means of which surprising results have been secured. In the most severe cases amputation or disarticulation of the thigh has been performed.

Hygroma of the iliac bursa is sometimes observed in the form of a circumscribed tumor, when the bursa does not, as usual, communicate with the hip joint. The other bursæ also—e. g., in the region of the trochanters—may become inflamed. The treatment of hygromata consists in their puncture, with or without the subsequent injection of iodine, or in laying them open or excising them.

By the so-called “rider’s bone” is understood the formation of bone in the adductors of the thigh in consequence of constant riding. For this myositis ossificans, and the very peculiar myositis ossificans multiplex progressiva, the reader is referred to Principles of Surgery, page 551. Massage, the inunction of mercurial ointment, and the use of iodide of potassium internally are especially to be recommended at the beginning of the affection.

Inflammations of the Femur.—Among inflammations of the femur I mention especially acute osteomyelitis resulting from infection with the *Staphylococcus pyogenes aureus*, less often with the *Staphylococcus pyogenes albus* and *Streptococcus pyogenes*. The region of the lower epiphysis of the femur is the favourite seat of this acute osteomyelitis. For the etiology, the course and the treatment of acute osteomyelitis, the reader is referred to Principles of Surgery, page 610 ff, where it is described more in detail. We there referred, also on page 617 ff., to inflammations of the femur among mother-of-pearl turners and those working upon wool and jute fabrics, also inflammations during the period of growth (growing-fever), the hyperostoses (elephantiasis) of the femur, etc. Separation of the epiphyses of the femur was described on page 637, Principles of Surgery. For echinococcus of the femur and the tibia, see § 342, page 800.

For necrosis of the femur and its treatment by sequestrotomy (necrotomy), the reader is likewise referred to Principles of Surgery, § 106, page 630 ff. The necrosis is most frequently found at the lower end of the femur, where the removal of the necrotic bone is sometimes attended with great difficulties. The operation is much facilitated by using an Esmarch bandage. A probe is introduced into the fistulous tracts, and the fistulæ of the bone (cloacæ) are then exposed as far as possible by detaching the soft parts and the periosteum sufficiently by means of a periosteal elevator. Proper attention is to be paid thereby to the location of the large vessels and nerves and the boundaries of the knee joint. The bone is then chiselled open to a sufficient extent, and the sequestrum is extracted.

§ 325. **Tumours of the Thigh.**—All the different kinds of tumours occur in the thigh, especially those of the connective-tissue type. In the subcutaneous adipose tissue there develop especially lipomata, fibromata, angeio-lipomata, and myxo-lipomata. Deeply located lipomata are also observed under the glutæus maximus muscle. The pedunculated lipoma sometimes reaches a very marked size. I saw an angeio-lipoma in an infant nearly as large as the fist wholly disappear spontaneously within a year. The soft fibromata also which originate in the intermuscular septa and the fascia may reach a marked size. They are likewise pedunculated sometimes. The myxomata originating in the muscles and the intermuscular septa are located, in most cases, on the posterior aspect of the thigh below the buttocks, whence they grow through the sacro-sciatic foramina into the pelvis (Lücke).

Neuromata develop most commonly on the sciatic nerve, sometimes as genuine neuromata, more frequently as fibro-neuromata and neuro-

sarcomata, originating in the nerve sheath or the interfibrillary connective tissue of the nerves. They may be detached from the nerve with preservation of its continuity, or it may be necessary to resect some of the nerve. In the latter case the ends of the nerve are united, either directly after stretching the latter or by means of a plastic operation (see § 295, page 606, Treatment of Nerve Defects in the Forearm).

Tumours in the inguinal region originate chiefly in the lymphatic glands and lymphatic vessels which are found there—that is, they are lymphadenomata, lymphosarcomata, and lymphangeiomata. The latter form soft tumours, which are usually composed of a convolution of thick cords. Lücke extirpated a cysto-adenoma of the inguinal region which had probably developed from an ovary situated in a femoral hernia.

The most common tumour is the sarcoma in its various forms. It originates sometimes in the soft parts—e. g., in the vessel sheaths, the



FIG. 821.—Cysto-sarcoma of the femur.

intermuscular septa, or in the fascia, sometimes in the periosteum and the medulla. The periosteal and myelogenic osteo-sarcomata are found especially in the region of the epiphyses, but also on the shaft of the femur. The very malignant forms of sarcoma, the melanotic sarcoma, and the rapidly growing medullary cancers, are rather frequent. Traumatism plays an important part in sarcoma formation. I saw a rapidly growing round-celled sarcoma which developed in the case of a student twenty years of age after a fall while practising in the gymnasium. The patient died from recurrence and internal metastases about a year after amputation at the hip. The rapidly growing sarcomata with abundant cells, which are observed especially among young persons, generally have a very unfavourable

prognosis. A recurrence usually occurs in the stump, as in the case just quoted, in spite of high amputation of the thigh or disarticulation at the hip, and the patient speedily dies of internal metastases. The least malignant sarcomata are the myelogenic osteo-sarcomata (myeloid sarcomata, giant-celled sarcomata, and cysto-sarcomata, Fig. 821, after W. Busch). They usually develop slowly, inflating the bone more and more, and then breaking through. Malignant forms, how-

ever, are also observed. Vascular, pulsating sarcomata occur here also, as on the humerus, at the upper and especially at the lower epiphysis of the femur. The diagnosis of these epiphyseal sarcomata is sometimes difficult at first on account of the swelling. One thinks first usually of primary chronic inflammation of the knee joint, or white swelling. The prognosis of the myeloid sarcoma after amputation of the femur is generally favourable. A permanent cure usually results.

The cysts of the thigh are of variable origin. Those in the inguinal region are mostly empty hernial sacs, which have ceased to communicate with the peritoneal cavity. The large cysts that occasionally occur on the inner side of the thigh are mostly, according to Michel, congenital pouches of peritonæum that have become shut off. The echinococcus is sometimes found in the thigh and leg (see § 342, page 800). Echinococcus of the bone occasions at first an inflation of the same similar to that attending the myelogenic tumours of the bone, and the diagnosis is only possible, as a rule, when the vesicles have broken through the cortical layer of the bone. Echinococcus also occurs in the soft parts—e. g., in the inguinal region and the region of the adductors, in the form of a lobulated tumour. The correct diagnosis can be reached by aspiration and microscopic examination of the contents of the cyst (see also § 161, page 53 ff., Echinococcus of the Liver).

Among non-malignant tumours of the bone the exostoses of the femur are especially to be mentioned. They are found most frequently at the lower epiphysis (Fig. 822). The exostoses or osteomata originat-

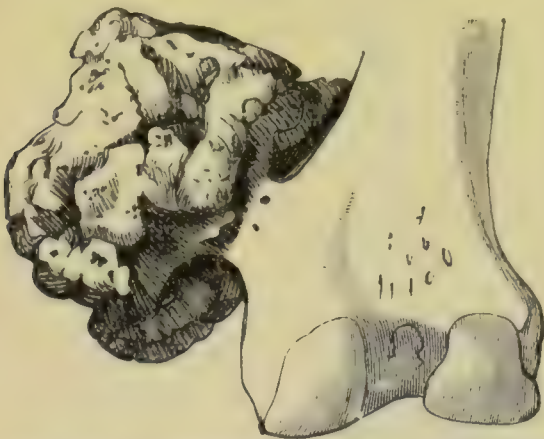


FIG. 822.—Exostosis of the femur (W. Busch).

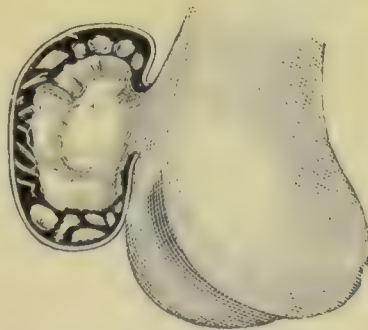


FIG. 823.—Exostosis bursata of the lower epiphysis of the femur with the formation of villous outgrowths and free joint bodies (Billroth and Rindfleisch).

ing in the periosteum are often perfectly movable, and not connected at all with the bone. The bony structure of osteomata or exostoses is sometimes as compact as ivory, and sometimes more cancellous. The exostoses in the region of the epiphyseal cartilage usually have a covering of cartilage (cartilaginous exostosis). They are really ossified en-

chondromata or ecchondroses. By exostosis bursata (Fig. 823) is understood an exostosis near a joint—e. g., the knee joint, with a bursal or synovial covering. It originates in the joint, and, in consequence of the longitudinal growth of the femur, pushes before it the capsule of the knee joint. The pouch thus made in the capsule either remains open, so that the synovial covering of the exostosis still communicates with the joint, or it is gradually shut off from the joint, as in Fig. 823. Free bodies are sometimes found in the sac, as Fig. 823 likewise shows. Such an exostosis bursata was observed by Bergmann on the outer side of the lower end of the femur, which had an extra-articular location close above the knee joint. About five hundred free rice bodies, consisting of hyaline cartilage, were found in the completely closed synovial sac. Volkmann observed an exostosis still located in the knee joint, which was attached near the point of reflection of the capsule upon the semilunar cartilage. There were three movable bodies in the knee joint.

Epithelial tumours are rare on the thigh. Balthge observed numerous cutaneous horns in the region of the thigh and the hip (Fig. 824).

Epitheliomata are rare on the thigh. The carci-



FIG. 824.—Multiple cutaneous horns on different parts of the body, particularly on the thigh and hip region. Some of these tumours are twelve to sixteen centimetres in length.



FIG. 825.—Carcinoma of the femur in a woman fifty-six years old who had had for four years a scirrhus cancer of the breast. The femur was diffusely softened and markedly bent (Volkmann).

nomatous lymphomata of the inguinal glands develop secondarily after carcinoma of the urinary and sexual organs and the lower extremity.

Carcinoma may develop secondarily in the bone also, as shown, for example, in Fig. 825. For primary and secondary carcinoma of the extremities the reader is referred to what was said in § 303, page 635.

The treatment of tumours conforms to general rules. In all cases of malignant tumours, especially of malignant sarcomata developing in the soft parts or in the bone, amputation or disarticulation of the femur is to be performed as soon as possible. It must be confessed that the possibility of a permanent cure in a case of malignant tumour of the femur that demands disarticulation at the hip is very dubious. Bock, who made a careful study of one hundred and nine such cases of disarticulation at the hip, reaches the conclusion that in not a single one of the eighty-six cases in which the patient survived the operation could a permanent cure be surely proved, and that in no case, perhaps, was life prolonged thereby. One must therefore most carefully consider in each case whether or not it is right or permissible to expose the patient to the danger of such a serious operation.

§ 326. **Resection of the Hip.**—The resection of the hip is usually a partial resection. It consists in the removal of the head of the bone, the acetabulum being almost always spared. Carious areas in the latter can easily be removed, after resection of the head or the neck of the femur, with a sharp spoon, and in case of retro-acetabular abscesses an enlargement of the opening in the bone is sufficient. The head of the femur used to be resected through or below the trochanter, especially in case of tubercular hip disease, because a careful extirpation of the diseased capsule is then possible, drainage is facilitated, and, later, the mobility of the joint is greater. On the other hand, the leg is considerably shortened thereby. We have already called attention to the fact that by packing the wound with iodoform gauze one can perfectly well preserve the neck. One should proceed as conservatively as possible in operating upon the hip, and resection is performed at present, among children, for example, with tubercular hip disease, by no means so frequently as formerly. Very good results have been secured, as in other joints, by the injection of ten-per-cent sterilized iodoform-glycerin or iodoform oil.

We always operate, if possible, subperiosteally—that is, the muscular insertions on the great trochanter are detached, together with the periosteum, or chiselled away with some of the cortical layer. The lesser trochanter—on which the ilio-psoas muscle, a very important one for the thigh, is inserted—remains intact. The operation is very easily performed when there is suppuration or tubercular inflammation of the hip joint. It is more difficult in fresh injuries or on the cadaver, on account of the firmness of the capsule and the liga-

ments. Resection of the femur is most frequently performed by means of a longitudinal incision over the trochanter, after Langenbeck. In order to secure good healing without a fistula, I consider it of the utmost importance that after the resection is completed—e. g., on account of tuberculosis—all bits of tissue, and all tubercular material, etc., should be most carefully removed by irrigation with bichloride or salt solution. It is my opinion that fistulæ are the result usually of leaving tubercular material behind.

Subperiosteal Resection of the Hip by means of a Longitudinal Incision over the Great Trochanter (Fig. 826).—The patient should lie upon the sound side, with the hip joint which is to be resected in a position of

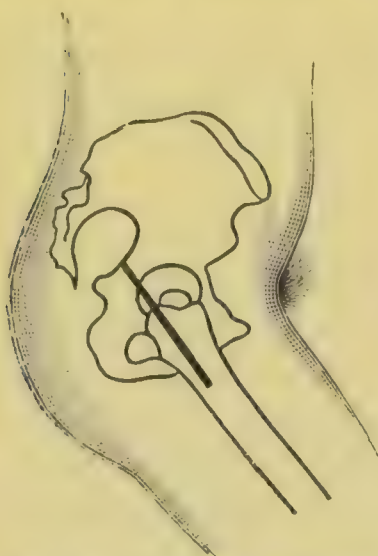


FIG. 826. — Langenbeck's incision for resection of the hip.

semiflexion. The skin incision, which is from ten to twelve centimetres long, runs upward from the base of the trochanter and in its middle line toward the posterior superior spine of the ilium. It is made at once down to the bone, dividing the skin, the fascia, the periosteum of the trochanter, and the gluteal muscles at one stroke. The capsule is also immediately opened and the rim of the acetabulum exposed. The edges of the wound are drawn apart by means of retractors, and any wounded vessels are immediately tied. The periosteum and the muscular insertions on the great trochanter are now detached subperiosteally with a periosteal

elevator in an outward and inward direction, together with the capsule, which is likewise divided by the longitudinal incision, or, still better, they are chiselled away together with a layer of the cortex. The cotyloid ligament is then repeatedly notched with the knife, and the ligamentum teres—which, in case of tubercular coxitis, for instance, is often destroyed—is either torn out by rotation of the femur or divided transversely by the introduction of a knife into the joint from behind and the outer side, after the head has been forced halfway out of the acetabulum by means of adduction and rotation inward. After division of the ligamentum teres, the head of the femur is completely dislocated by means of flexion, adduction, and rotation inward or outward, and cut off with a chain saw, metacarpal saw, or a chisel, either, as cited above, below the great trochanter, after Malgaigne, Sayre, Volkmann, and others, or, according to the method of Langenbeck, Hueter, and others, with preservation of the trochanter, or, it may be, through the latter itself with preservation of a part of the neck. After

the removal of the articular surface of the femur the acetabulum can be sufficiently inspected and, if necessary, scraped out, and the capsule can be excised with scissors and forceps. Bardenheuer, Hans Schmid, and others resected the diseased acetabulum in suitable cases with the chisel. The wound is either drained and sutured or packed with iodoform gauze. Generally speaking, I prefer the latter method of treatment.

Resection of the Hip by means of the Posterior Curved Incision (older method of Textor and Anthony White).—The patient lies upon the sound side, and the hip joint is either nearly extended or flexed as completely as possible. In the former case the incision is made as indicated in Fig. 827, in the latter case the more angular incision represented in Fig. 828 is chosen. The curved incision begins midway between the anterior superior spine of the ilium and the upper border of the great trochanter, encircles the top of the latter, and then runs

downward for a distance of about five centimetres along the posterior border of the same. In operating according to Fig. 828, with the joint in a position of maximum flexion, a rectangular incision is made which encircles the upper and posterior borders of the trochanter at a distance of from two to three centimetres. The tendinous insertions of the glutæus me-

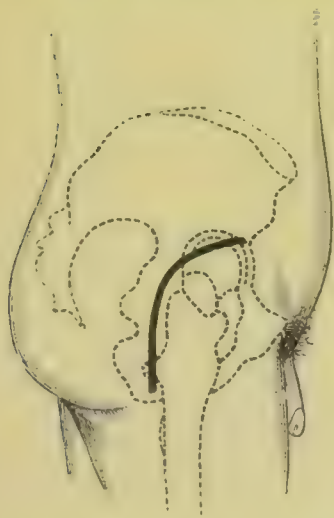


FIG. 827.—Resection of the hip; posterior curved incision with the hip extended.

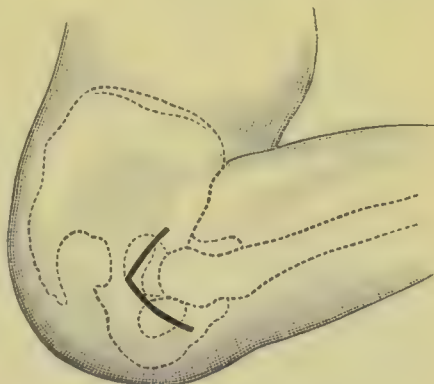


FIG. 828.—Resection of the hip; posterior angular incision with the hip sharply flexed.

dius and glutæus minimus, the obturators, the pyriformis, and the quadratus femoris muscles are detached from the trochanter until the capsule is reached, which is then opened. The cotyloid ligament is now notched, as in Langenbeck's method, and the ligamentum teres is either torn away by adduction of the femur and rotation inward or outward, or divided with the knife from behind and the outer side. After dislocation of the head of the femur by adduction and rotation, the neck of the bone can be sawn off with a metacarpal saw or a chain saw, here also either through or below the great trochanter. In the latter case it is a good plan to detach the soft parts, from the trochanter, subcortically with hammer and chisel, as in Langenbeck's method. The lesser trochanter with the insertion of the ilio-psoas

muscle remains intact. The rest of the operation (excision of the capsule, scraping out the acetabulum, or chiselling it out with a gouge, etc.) is the same as above.

Resection of the Hip by means of an Anterior Longitudinal Incision, after Lücke, Schede, and Hueter (Fig. 829). The soft parts suffer the least injury by these incisions, but they do not afford a sufficiently free view into the joint. They are, therefore, best suited for the simple decapitation of the femur—e. g., in case of wounds of the joint, and less so for more extensive

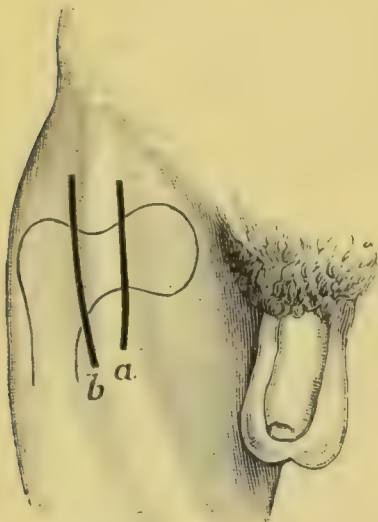


FIG. 829.—Resection of the hip ;
a, anterior incision after Lücke
and Schede ; b, after Hueter.

diseases of the hip. Lücke and Schede make the anterior longitudinal incision along the inner border of the sartorius muscle (Fig. 829, a). Hueter makes it on the outer border of the same, at a greater distance from the anterior crural nerve (Fig. 829, b). The incision as made by Lücke and Schede begins below and to the inner side of the anterior superior spine of the ilium, and runs downward for a distance of from ten to twelve centimetres. One passes in between the inner border of the sartorius and the rectus femoris muscles on the one side and the outer border of the ilio-psoas on the other. The muscles named are drawn outward and inward by means of retractors, and the anterior portion of the capsule is opened while the leg is partially flexed, abducted, and rotated outward. Hueter begins his longitudinal incision on the outer bor-

der of the sartorius muscle, at the centre of a line which connects the great trochanter and the anterior superior spine of the ilium. After isolation of the neck of the femur, it is divided with the chisel or saw from above and the outer side in a downward and inward direction. If the trochanter is to be removed at the same time, it can be better done through Hueter's incision than through that of Lücke and Schede.

Tiling begins Langenbeck's incision farther forward upon the anterior border of the trochanter, in order to retain a larger portion of the insertions of the gluteal muscles on the top and in the fossa of the great trochanter. Through this incision he chisels away the trochanter with the periosteum and the muscular insertions, and displaces it backward. The capsule is now detached in front, and the thigh is rotated outward in order that the lesser trochanter may be brought into view and chiselled off. The head is then dislocated, and one proceeds according to the nature of the case—that is, the capsule is dissected out, the head is resected, the acetabulum is scraped, chiselled out, etc. If the head of the femur is sound, it is preserved and brought back into the acetabulum. The great and lesser trochanters are fixed in their normal place again with ivory pins.

Ollier has recently recommended the following method for resection of the hip : The curved skin incision (*à tabatière*) encircles the trochanter in such a way that its lowest point lies about four centimetres below the apex of the latter, and its ends are respectively four centimetres in front of and

behind it. The great trochanter is then sawn off from without inward, and from below obliquely upward, and the fragment thus obtained is reflected with the skin and the gluteal muscles. The neck and head of the femur are well exposed in this way, and can be further operated upon or resected as necessity may require. After the operation is completed, there follow drainage, reposition of the sawn-off fragment of bone, and fixation of the same by suture.

Bardenheuer has in some cases of acute osteomyelitis and tubercular caries resected or chiselled out the acetabulum, either with or without simultaneous resection of the head of the femur.

The after-treatment of resection of the hip consists in the application of an antiseptic protective dressing over the wound, and of an extension apparatus with the leg abducted and the pelvis elevated (see Principles of Surgery, page 225 ff.). The effort is made, of course, to secure as movable a joint as possible. I agree with Olvier, however, that in all cases of suppurative inflammation it is better to strive for ankylosis with the thigh slightly flexed and abducted. In case of resection of both hips, Volkmann advises that an immovable joint be secured on one side, with the leg in a good position in order that the patient may have a firmer support. After healing has taken place, extension by weights must still be made use of for weeks or months, especially in children. This extension should be applied, above all, at night, and it is best accomplished by the use of a gaiter reaching to the middle of the thigh with a leather sling for the foot.

The anatomical conditions in the hip joint after healing has taken place vary, of course, with the extent of the resection and the age and disease of the patient. One sometimes observes a complete reorganization of the joint—e. g., new growth of the resected trochanter and of the head of the femur, with reorganization of the acetabulum. It has been repeatedly found that the lesser trochanter, with a cartilaginous covering, rested in the acetabulum and formed a substitute for the head. In other respects the anatomical conditions found in the resected hip joint depend upon whether partial or complete ankylosis, an actively movable hip joint or a loose joint, results.

§ 327. **Disarticulation at the Hip.**—A sure control of the hæmorrhage is of the greatest importance in performing disarticulation of the femur, in order that the operation be performed with a minimum loss of blood. The best method, in my opinion, is first to perform a high amputation of the thigh, with the use of Esmarch's bandage (see Principles of Surgery, Fig. 32, page 53), and then, after tying the vessels in the wound, to remove the upper end of the femur through a longitudinal incision over the trochanter. The mortality attending disarticulation at the hip before the adoption of antiseptic methods amounted, according to Lüning, to seventy per cent, and according to Ashhurst, to sixty-

four per cent (633 cases). Most of the patients died in consequence of the great loss of blood, inasmuch as the methods of arresting hæmorrhage were very defective.

The high amputation of the thigh, with subsequent disarticulation of the stump, is performed as follows: Esmarch's India-rubber tube is applied, parallel to Ponpart's ligament, the extremity having been made bloodless by holding it perpendicular for some time. The tube is held in place by an assistant by means of a loop of bandage.

Wyeth secures the rubber tubing by means of two steel needles, about thirty centimetres in length, which are stuck through the thigh without injuring the large vessels. All the soft parts are divided to the bone by a circular incision about a hand-breadth below the trochanter and the bone is sawn through. All the vessels that are visible, both arteries and veins, are seized with artery clamps and tied with catgut or fine silk. The India-

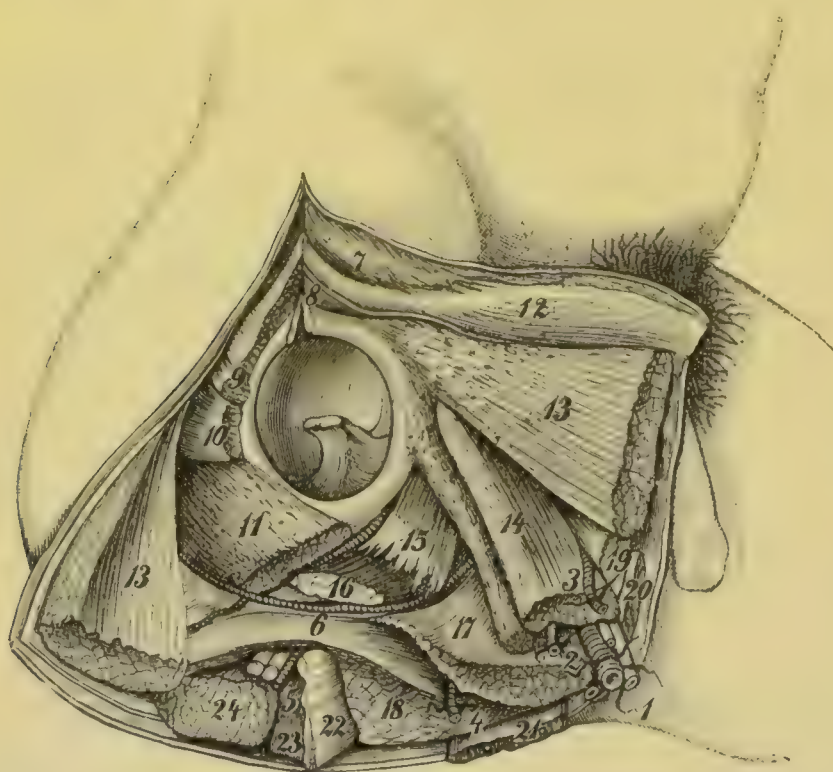


FIG. 830.—Anatomy of the wound after disarticulation at the hip: 1, femoral artery and vein with the long saphenous nerve; 2, external circumflex artery; 3 and 4, muscular and articular branches; 5, sciatic artery; 6, internal circumflex artery; 7 and 8, glutæus medius and minimus; 9, pyriformis; 10, obturator internus and gemelli; 11, quadratus femoris; 12, tensor fasciæ latæ; 13, vastus externus; 14, vastus medius and internus; 15, ilio-psoas; 16, pectineus; 17, adductor longus; 18, adductor magnus and brevis; 19, rectus femoris; 20, sartorius; 21, gracilis; 22, semimembranosus; 23, semitendinosus; 24, biceps (Rotter).

rubber tube is removed, while the wound is compressed by means of large sponges, and any vessels from which there is still hæmorrhage are ligated. The upper part of the femur is now removed, subperiosteally as far as possible, through a longitudinal incision over the middle of the trochanter. An amputation knife or a large resection knife is introduced at a point about five centimetres above the apex of the trochanter until it reaches the head of the femur, and a longitudinal incision is made downward over the middle of the trochanter to the wound made by the circular amputation, constantly cutting down to the bone.

The lower end of the stump of bone is now seized with strong bone forceps, the edges of the wound are retracted, the periosteum pushed back from the bone on all sides with an elevator, the muscular insertion severed from the great and lesser trochanter, the capsule opened, the ligamentum teres divided, and disarticulation of the head of the femur completed. The anatomy of the wound is shown in Fig. 830. Then follow drainage, suture, and the application of a dressing.

Roser's oval incision, after previous ligation of the femoral artery and vein just beneath Poupart's ligament, also makes very good provision for the control of the hæmorrhage. After ligation of the femoral artery and vein by means of a longitudinal incision just below Poupart's ligament (see § 322, page 726), a curved incision is made from the lower end of this incision toward the inner and outer side of the leg, and the two are united on the posterior aspect of the extremity below the gluteal fold by means of a semicircular incision. After dividing the skin the soft parts are incised down to the bone along the course of the oval incision, and each spurting vessel is immediately caught with an artery clamp and tied. Upon reaching the capsule, it is opened from in front, and the head of the femur dislocated by hyperextension. The bone is now enucleated, with suitable adduction and rotation of the thigh, first in the region of the great trochanter, always cutting against the bone, and, finally, the capsule and the muscular insertions on the posterior and inner aspect of the thigh are divided.

Rose makes an anterior and posterior flap and then gradually works his way inward, as when operating upon tumours, and ties each vessel proximally and distally before its division. This method consumes time, it is true, but it enables one to restrict the hæmorrhage within narrow limits, and therefore decidedly deserves to be considered in suitable cases. Senn opens the joint through Langenbeck's incision over the trochanter, lays bare the head and the region of the trochanter, and dislocates the head. The soft parts are then constricted in front and behind and *in toto* by means of an India-rubber tube. An anterior and posterior flap of soft parts are now formed without loss of blood by means of an anterior and a posterior curved incision, starting from the trochanter incision, and the disarticulation is completed.

Disarticulation at the hip after previous ligation of the common iliac artery and vein (see § 157, page 32), with the formation of an anterior flap, is a very good method (Trendelenburg, Rose).

The old French transfixion method is to be rejected on account of the serious and unavoidable loss of blood. The patient is so placed, with the upper part of the body well fixed, that the pelvis on the dis-

eased side extends halfway over the edge of the operating table. Loss of blood is prevented by Esmarch's tube, compression of the aorta against the spine in the way shown in Fig. 33, page 53, of Principles of Surgery, as well as digital compression of the external iliac artery against the ramus of the os pubis. A large anterior flap of skin and muscle is then cut by inserting a long, sharp transfixion knife midway between the anterior superior spine of the ilium and the top of the trochanter. The knife is passed inward close to the bone and parallel to Poupart's ligament, so that its point emerges near the perinæum. It is then carried downward close to the bone with sawing strokes. An assistant inserts his hands under the flap behind the knife and compresses the vessels in the flap. One can also compress the vessels by means of a steel rod carried through the puncture canal, around whose ends an India-rubber tube or some turns of a bandage are tightly tied, or by thrusting through a flexible needle of lead or zinc (Trendelenburg). The knife is now carried from below toward the surface through the skin, and a flap of skin and muscle is formed from fifteen to twenty centimetres long. Then follows ligation of the femoral artery and vein with their branches. A small posterior flap is then made, the thigh hyperextended, the capsule opened, and the disarticulation completed. Ligation of the vessels, drainage, and suture follow.

§ 328. **Amputation of the Thigh.**—Amputation of the thigh is most frequently performed by the circular method at two levels, or by a flap method, such as the formation of an anterior overhanging skin-flap.

The circular amputation at two levels is performed as follows: After applying Esmarch's tube, the operator stands in such a way that the foot of the extremity which is to be amputated lies on his right side—that is, if it is the right leg, the surgeon stands outside of it; but if the left leg, he stands between the two. The skin is divided by a circular incision with sawing strokes of the knife, dissected up from the underlying fascia, and reflected in the form of a cuff. The length of this cuff of skin must equal half the diameter of the thigh. If the cuff can not be reflected owing to the fact that its lower circumference is too small and the extremity increases in size above, it is divided by a longitudinal incision either in one place or in two opposite places—e. g., on the sides. After reflecting this cuff of skin, the soft parts are divided down to the bone by means of a circular incision with sawing strokes. The bone is then sawn through, the vessels that are visible tied (the femoral artery and vein and the profunda, as well as a number of muscular branches), and the large nerve trunks, especially the sciatic nerve, are drawn out and cut off short with scissors. The

wound is drained, especially posteriorly, sutured in a transverse direction, and a dressing applied. The anatomy of the wound (about the middle of the thigh) is shown in Fig. 831. The numerous muscular branches are not included in the cut.

The funnel-shaped or conical incision, after Boyer, is also very useful for amputation in the middle third or higher up. A circular incision is made through the skin and fascia down to the most superficial muscular layer. The edges of the wound in front and behind, as well as on the inside and outside, are drawn upward by means of four double-pronged retractors, and the muscles are divided, with the exception of the muscular layer next to the bone, by a somewhat oblique circular incision. The severed muscles are drawn upward by means of retractors inserted deeper, and below these the deepest muscular layer is divided down to the bone. In this way a conical or funnel-shaped wound is obtained and an abundant, well-nourished covering of soft parts for the bone.

Among flap amputations the formation of a large anterior overhanging flap and a smaller posterior flap (Teale, Bruns) is especially to be considered (see Principles of Surgery, Fig. 102, page 119). The position of the operator is the same as in circular amputation. An anterior semilunar cutaneous flap is first marked out, whose base answers to at least half the circumference of the limb and whose length equals the thickness of the thigh. This flap, which contains the skin and the subcutaneous adipose tissue, is dissected up from the fascia and reflected. One may also include some of the muscle in the flap for the sake of securing for it better nourishment. A short cutaneous flap is formed posteriorly simply by making a semicircular incision. This cutaneous flap also is dissected up from the subjacent parts and reflected. All the soft parts are now divided to the bone by a circular incision just



FIG. 831.—Transverse section of the thigh at about the middle: 1, femoral artery and vein with the long saphenous nerve; 2, profunda artery and veins; 3, sciatic nerve and artery; 4, internal saphenous vein; *R*, rectus femoris; *Q*, quadriceps; *Ve*, vastus externus; *Vm*, vastus medius; *Vi*, vastus internus; *S*, sartorius; *A*, adductors; *G*, gracilis; *Sm*, semimembranosus; *St*, semitendinosus; *Bi cl*, long head of the biceps with the short head behind it.

below the reflection of the flap, and the bone is then sawn through, the soft parts of the stump being drawn upward.

For the transcondyloid amputation of the thigh and Gritti's method, see § 344, pages 807, 808.

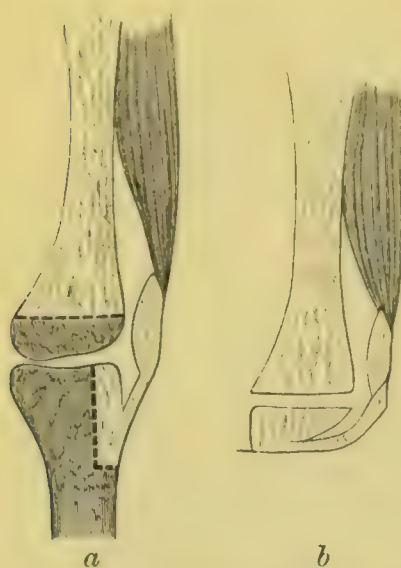


FIG. 832.—Sabanejeff's osteoplastic amputation of the femur.

W. Koch has recommended the method of Sabanejeff (Odessa) for amputation of the femur. It can be easily understood from Fig. 832, *a* and *b*. Two longitudinal incisions are made through the skin and the muscles from the head of the fibula and from the internal lateral ligament to about the beginning of the middle third of the leg. These are connected in front by a transverse incision two finger breadths below the tubercle of the tibia and behind by a somewhat higher transverse incision. The posterior flap is formed first, and consists only of skin. The knee joint and the tibio-fibular joint are opened from behind and the crucial and lateral ligaments of

the knee are severed. In sawing the bone-flap from the tibia the leg must be turned forward against the anterior surface of the thigh. The further course of the operation is clear from the two illustrations. The fragment of the tibia fits closely against the wound surface of the femur without suture or nailing, and the stump affords an excellent support.

CHAPTER XXXIV.

INJURIES AND DISEASES OF THE KNEE JOINT AND THE LEG.

Mechanism of the knee joint.—Contusions and sprains of the knee.—Dislocations of the knee.—Displacement of the semilunar cartilages.—Dislocations of the patella.—Absence and rudimentary formation of the patella.—Rupture of the ligamentum patellæ and of the quadriceps tendon.—Dislocations of the fibula at the superior tibio-fibular articulation.—Fractures of the lower end of the femur.—Fractures of the upper end of the tibia and fibula.—Fractures of the patella.—Wounds of the knee joint.—Ligation of the popliteal artery.—Aneurisms.—Acute and chronic inflammations of the knee joint.—Free bodies in the knee joint.—Contractures and ankylosis of the knee joint.—Genu valgum.—Genu varum.—Diseases of the bursæ in the vicinity of the knee joint.—Tumours in the region of the knee joint.—Resection (arthrectomy, synovectomy) of the knee joint.—Disarticulation and amputation at the knee joint (Gritti's trancondyloid amputation of the femur).—Fractures of the shaft of both bones of the leg.—Fracture of the shaft of the tibia and of the fibula alone.—Injuries of the soft parts of the leg.—Ligation of the anterior and posterior tibial artery.—Diseases of the leg (soft parts and bones).—Osteotomy of the tibia and fibula.—Necrotomy (sequestrotomy).—Amputation of the leg.—For the technique of bandaging the knee, see Principles of Surgery, §§ 50-55.

§ 329. **Mechanism of the Knee Joint—Contusions and Sprains of the Knee.**—A knowledge of the mechanism of the knee joint is of great importance for the understanding of sprains and dislocations.

Mechanism of the Knee Joint.—The movements of the knee consist of flexion, extension, and a certain amount of rotation. The latter takes place especially at the end of extension and at the beginning of flexion. At the end of extension the tibia rotates outward upon its long axis, while at the beginning of flexion it rotates inward. This rotation of the tibia or the leg is a result of the peculiar form of the condyles of the femur, in that particularly the internal condyle deviates somewhat at its anterior end from the purely sagittal direction—that is, it takes a rather sudden outward curve. When the knee joint is flexed, independent rotation of the leg is possible. The rotation of the tibia is brought about mainly by the movement of the outer semilunar cartilage, which moves upon the conical articular surface of the outer condyle of the tibia. The posterior crucial ligament is made tense thereby. The range of movement of the tibia in these rotation movements has been carefully measured by the Weber brothers and by Meyer. The angle of rotation at the end of extension amounts on the average to 39°; that in flexion—e. g., a flexion of 60°—amounts at the maximum to 52°.

The movements of the knee joint are checked partly by the semilunar cartilages, the capsule with its accessory bands, and the crucial ligaments, and partly by direct contact between the condyles of the femur and the tibia. Flexion is checked by the anterior crucial ligament, by the edges of the semilunar cartilages, and by the direct contact of the femur and the tibia in their posterior parts. Extension is checked mainly by the semilunar cartilages, especially the outer one. In consequence of this constant incarceration of the semilunar cartilages, there may be seen on the condyles of the femur a corresponding impression, which is most distinct on the outer condyle. Extension of the knee is checked by the posterior crucial ligament, the posterior portion of the capsule, and the lateral ligaments. Hönigschmied in particular has made a study upon the cadaver of ruptures of the ligaments of the knee. Forceful hyperflexion does not produce rupture of the ligaments in an intact cadaver, while in hyperextension the posterior portion of the capsule and the crucial ligaments are torn away, one or both lateral ligaments and the semilunar cartilage are torn off, the femur is fractured above the condyles, the epiphysis of the femur is separated, or the leg dislocated forward. Lateral flexion to the inner side (hyperadduction) causes rupture of the external lateral and the anterior and posterior crucial ligaments, the capsule, the outer semilunar cartilage, less often of both semilunar cartilages, supracondyloid fracture of the femur, separation of the epiphysis, fracture of the internal condyle alone, crushing of the tibia on the inner side, fracture of the head of the fibula, or dislocation of the leg inward. Forceful lateral flexion to the outer side (hyperabduction) causes the same injuries as hyperadduction, but on the opposite side. Forceful rotation on the vertical axis inward (hyperpronation) and outward (hypersupination) causes the same stretching and ruptures of the soft parts, furthermore, in old individuals, spiral fractures of the tibia and fibula, less often of the femur, and in children, separation of the lower epiphysis, and finally in rare cases dislocation of the leg inward and outward.

The joint between the tibia and the fibula (superior tibio-fibular articulation) is of but little surgical importance. A slight amount of gliding movement of the articular surfaces in a transverse and a sagittal direction are possible which enables the lower ends of the two bones to move more easily at the ankle joint. Both movements are checked by the ligaments of the head of the fibula. Rotation is not possible in this articulation.

Symptoms and Treatment of Contusions and Sprains of the Knee.—The most important symptom of a contusion or sprain of the knee joint is a corresponding effusion of blood into the joint (hæmarthros). The joint is sometimes so distended with blood that the patella is lifted from the subjacent parts, and when pressed back springs forward again. The hæmarthros may easily pass into chronic serous effusion in case of unsuitable treatment. Suppuration occurs only in very rare exceptions—e. g., in consequence of infection through the circulation, or from erysipelas or cellulitis proceeding, for example, from a break in the skin. Tuberculosis of the knee joint not infrequently develops from traumatism in persons predisposed thereto. In case of

marked effusion into the joint and the surrounding tissue, a careful examination should be made with reference to the existence of a fracture. There are sometimes subcutaneous ruptures of the tendons or the capsule.

The treatment of a contusion and sprain of the knee joint, or the hæmarthros conditioned thereupon, consists, above all, in a prompt use of massage and in active and passive movements of the joint. Compression of the joint for a time by means of elastic bandages or India-rubber knee-caps is strongly to be recommended. For the first few days the application of an ice bag may be serviceable in relieving the pain. In case of ruptures of the tendons and the capsule, the joint should be immobilized at the outset until the rents in the capsule and tendons have healed. In ruptures of the tendons, suture of the same is to be performed. Aseptic puncture of the knee joint with a trocar or aspirating needle, or by simple incision with the knife, is to be performed only in rare cases when there is a very large effusion of blood, or when the absorption of the latter is very slow, or when chronic serous effusion results therefrom. Strict antiseptic precautions are to be observed, and the entrance of air into the joint is to be avoided as far as possible. I do not employ in such cases subsequent irrigation of the joint with a three-per-cent solution of carbolic acid or 1-in-1,000 bichloride.

§ 330. **Dislocations of the Knee.**—Dislocations of the knee in either a forward, backward, outward, or inward direction are rare, and it requires the action of considerable violence to lift the broad articular surfaces completely from one another and to rupture the stout ligaments of the joint. When the ligaments and capsule are put upon the stretch, fracture of the lower end of the femur is much more likely to result. Incomplete dislocations of the tibia are the most common.

1. **Forward Dislocation of the Knee** (Figs. 833 and 834).—This commonest form of dislocation of the knee arises usually from hyperextension of the joint combined with violent abduction and rotation—e. g., in consequence of a fall from a considerable height or of direct violence against the front of the femur. The dislocation is due to the fact that the femur is driven against the posterior part of the capsule, and the latter is ruptured here.

The crucial and the lateral ligaments are often ruptured as well. Complete dislocations are, in consequence of the great violence that has

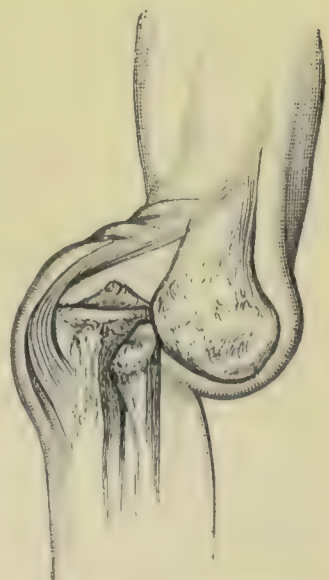


FIG. 833.—Complete dislocation of the knee forward.

acted, not infrequently compound, so that the ends of the bones protrude through the skin. The popliteal artery and vein and the sciatic nerve are usually preserved, and lie tensely stretched in the groove between the condyles of the femur. The two heads of the gastrocnemius muscle are generally severely contused. The tibia is sometimes

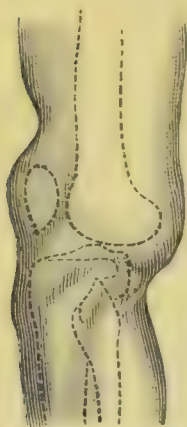


FIG. 834.—Partial dislocation of the knee forward.

completely dislocated (Fig. 833). In an incomplete dislocation the end of the femur rests upon the posterior border of the tibia (Fig. 834). The articular surface of the tibia or the femur is sometimes fractured, or the head of the fibula may be torn off by the external lateral ligament. The tibio-fibular joint is more or less involved.

The symptoms of a complete dislocation of the tibia forward are very apparent (Fig. 833). The antero-posterior diameter of the joint is considerably increased, and the tibia can be distinctly felt projecting in front and the condyles of the femur behind. The leg is overextended at the knee joint and shortened, especially when the dislocated bones override. The patella lies in the depression above the tibia. In consequence of the compression of the popliteal artery, the pulse in the dorsalis pedis artery and the posterior tibial artery behind the internal malleolus is indistinct, and the patient complains of a feeling of numbness in the foot as the result of pressure upon the sciatic nerve. Active movement of the knee joint is impossible, and passively further extension is alone possible. Essentially the same symptoms are present in an incomplete dislocation of the tibia forward, but they are not so distinct as in complete dislocation. In fat and muscular persons forward dislocation of the tibia is most easily confused with a transverse supracondyloid fracture of the femur. A correct diagnosis can be reached by means of a thorough examination with the patient under an anæsthetic.

The prognosis of complete forward dislocation of the tibia is unfavourable so far as the restoration of the function of the knee joint is concerned. A loose joint usually results, in consequence of rupture of the crucial ligaments. After incomplete dislocations also the function of the joint is generally permanently impaired. I saw marked genu valgum with loose joint result from an incomplete dislocation. The prognosis is very unfavourably affected by associated injuries, especially by contusions of the large vessels and nerves in the popliteal space, or by their rupture, with gangrene and paralysis. Even after reduction of the dislocation circulatory disturbances, thrombosis, gangrene, and paralysis of the leg and the foot have been seen to result from the contusion and compression of the vessels and nerves in the popliteal space. The prognosis of compound dislocations of

the tibia forward has been improved by the antiseptic treatment of wounds. Formerly amputation of the femur was usually necessary in consequence of suppuration and sloughing of the knee joint.

The reduction of a forward dislocation of the knee is effected, with the patient under an anæsthetic, by traction on the leg and counter-traction on the thigh and by direct pressure upon the end of the tibia, with subsequent flexion. A slight amount of hyperextension may be combined with the traction, in order to free the posterior edge of the tibia from the femur; but this must be done with care, lest the vessels and nerves of the popliteal space be still more compressed and stretched. Should difficulty attend subcutaneous reduction, the joint should be opened and the obstacle removed.

Compound forward dislocations of the knee are treated in the same way, under antiseptic precautions, as other injuries of a joint, especially by drainage with resection, if necessary, of the joint (see Principles of Surgery, page 719).

2. Backward Dislocation of the Knee (Figs. 835 and 836).—This less frequent dislocation usually arises from direct violence when the knee joint is partially or fully flexed, so that the tibia is driven backward or the femur forward. Stetter



FIG. 835.—Complete dislocation of the knee backward.

observed this dislocation in the case of a soldier who, at a drill in active service, ran rapidly down a steep height, suddenly stood still and braced his left foot in the soft, clayey soil, and threw the upper part of his body violently backward. The dislocation is either complete (Fig. 835) or incomplete, so that the articular surfaces still remain in contact (Fig. 836). The rent in the capsule is usually posterior in the popliteal space. The lateral ligaments and the ligamen-

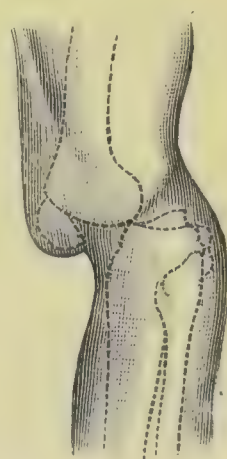


FIG. 836.—Partial dislocation of the knee backward.

tum patellæ may remain intact, while the crucial ligaments are always ruptured. The semilunar cartilages are generally displaced. The vessels and nerves in the popliteal space are likewise endangered in this dislocation. In front the tendon of the quadriceps muscle may be ruptured.

The symptoms of a backward dislocation of the knee are the reverse of those attending a dislocation forward. They are especially distinct in complete dislocations (Fig. 835). Here also the antero-posterior

diameter of the joint is increased. The prominent condyles of the femur with the patella can be felt in front, and the end of the tibia projects in the popliteal space. The leg is shortened and the knee joint is extended or hyperextended. Active movements of the knee are impossible, while passive movements can be executed only within narrow limits and are attended with severe pain. In incomplete dislocation the deformity is very much the same (Fig. 836), except that the femur is not so prominent in front or the tibia behind. The posterior portion of the condyles of the femur rests upon the anterior border of the tibia. In fat and muscular persons and in case of a marked effusion of blood, this dislocation, like the forward dislocation, may be mistaken for supracondyloid fracture of the femur. The correct diagnosis can be reached here also by means of a thorough examination under an anæsthetic.

The prognosis of backward dislocation of the knee joint after reduction is somewhat better, as regards the restoration of the function of the joint, than that of dislocation forward. Stetter's patient had paralysis of the peroneus longus muscle for some months, in spite of the fact that reduction was easy and was performed soon after the occurrence of the dislocation. The ability to walk well has repeatedly followed even unreduced, complete, and incomplete dislocations (Malgaigne, Lossen, Karewski). Gangrene of the foot and leg is also possible here, in consequence of rupture or thrombosis of the popliteal artery and vein.

The reduction of backward dislocations of the knee is most successfully accomplished by traction on the leg, counter-traction on the thigh or the pelvis, and direct pressure upon the dislocated articular surfaces. Slight flexion of the leg may be combined with the traction, in order to lift the dislocated articular surfaces from one another. If subcutaneous reduction is impossible, the joint should be opened and the obstacle to reduction removed. Compound dislocations are treated under antiseptic precautions and in accordance with the general rules applicable to the treatment of injuries of a joint (drainage and possibly resection of the joint).

3. Lateral Dislocations of the Knee.—These dislocations are very rare, and, as the tabulation made by Lossen shows, mostly incomplete. In complete dislocation of the tibia outward or inward, which usually requires severe violence, the skin is generally lacerated at the same time (compound dislocation). Dislocation outward seems to be more frequent than that inward. Hoffa mentions twenty dislocations outward and ten inward.

Lateral dislocations of the knee may result from violence acting laterally upon the thigh or the leg, from lateral bending of the knee joint when the leg is fixed—e. g., in consequence of a fall or in jump-

ing—or, finally, from injuries caused by machinery, etc. The outer or inner condyles of the femur and the tibia are completely, or more commonly only partially, lifted from one another by the action of the violence, with corresponding rupture of the capsule and the lateral ligaments on the outer or inner side of the joint.

The symptoms of outward or inward dislocation of the knee are usually very distinct, especially, of course, in case of complete dislocation, but also in the incomplete. The transverse diameter of the joint is increased, the upper end of the tibia projects distinctly on the outer or inner side, the patella always follows the tibia, and the lower end of the femur lies on the opposite side. The leg is either abducted or adducted.

The prognosis is not unfavourable, as regards the restoration of the function of the joint, if successful reduction promptly follows the injury. In case of unreduced dislocations, even when incomplete, the function is defective. *Genu varum* or *genu valgum* then develop, according as the dislocation of the tibia has taken place inward or outward, and this continues to grow worse. Reduction is usually accomplished by traction on the leg with counter-traction on the thigh or the pelvis, and by direct pressure upon the articular surface of the tibia.

4. Dislocations by Rotation.—These very rare dislocations arise, as the name indicates, from rotation of the thigh or the leg about its long axis, so that the tibia is turned outward or inward. Hoffa mentions cases that were observed by Dubreuil, Martelière, and Sulzenbacher. Reduction is effected by traction, rotation, and direct pressure.

The after-treatment of dislocations of the knee joint consists in immobilization of the joint for from two to four weeks by means of a splint or plaster of Paris, and then in massage and careful active and passive exercise of the joint.

Aseptic arthrotomy is indicated in all irreducible dislocations, and resection of the knee, it may be, in irreducible dislocations of long standing where the function is greatly impaired.

Congenital Dislocations of the Tibia.—Godlee, Barwell, Richardson, Porter, Maas, and others observed congenital dislocations of the tibia, usually forward or outward. The treatment consisted in reduction, under an anæsthetic, with the subsequent application of a plaster-of-Paris splint or an extension apparatus. At the outset a temporary splint or brace is worn.

Dislocation of the Semilunar Cartilages.—This condition consists, as a rule, in merely a partial displacement of the semilunar cartilage with incarceration of the same between the bones, in consequence of rupture, for example, of the anterior or posterior accessory ligament or of the cartilage itself. In the majority of cases the anterior attachment of the semilunar cartilage is torn away. The dislocation is therefore more correctly designated as rupture of the semilunar cartilage. P. Bruns has collected forty-three cases of disloca-

tion of the semilunar cartilages in addition to four which came under his own observation. The dislocation of the inner cartilage is twice as frequent as that of the outer one, because the former is more fixed than the latter. The inner semilunar cartilage is usually dislocated forward and the outer one either outward, inward, or backward. Dislocation outward and forward is more common than that inward and backward. It arises ordinarily from violent rotation of the knee when flexed. Dislocation of the inner cartilage arises from outward rotation of the leg when flexed and that of the outer one from inward rotation. We sometimes have to do with a gradual and not a sudden loosening or separation of the attachment of the cartilage, in consequence of frequently repeated movements of the knee joint. The condition is favoured by relaxed ligaments, by arthritis deformans, etc. Aside from these usually incomplete dislocations, complete dislocations of the cartilages, in consequence of the action of great violence, occur at best very rarely (W. Scott, Lang), and I am inclined, in fact, to doubt, with P. Bruns, whether they occur at all.

The symptoms are much the same as those attending the sudden incarceration of a free body in the knee joint—that is, they consist, after a stumble, for example, in severe pain, in fixation of the joint, usually in slight flexion, and in inability to extend the leg. The patient falls to the ground, it may be, without being able to rise again. Reduction sometimes ensues spontaneously after a few moments—that is, the nipped edge of the cartilage becomes free again and the symptoms disappear at once. Nicoladoni performed arthrotomy in one case on account of a supposed free body in the joint, and found a dislocation of the outer edge of a semilunar cartilage. The dislocation often recurs and becomes chronic. I observed a patient not long ago who could dislocate at will the inner cartilage of the left knee forward and inward, with a distinctly audible crackling of the joint, by rotation of the leg with the knee slightly flexed and subsequent extension. The edge of the cartilage could be distinctly felt as a projection between the femur and the tibia.

The reduction of dislocations of the semilunar cartilages, especially the usual incomplete dislocations, is, as has been said, often spontaneous. Reduction is most successfully accomplished by extension with subsequent sharp flexion of the leg and rotation of the same about its long axis. In case of displacement of the outer cartilage, the leg is rotated outward, and in displacement of the inner one it is rotated inward. The patient should remain in bed for about eight days. In order to prevent a recurrence, an elastic knee-cap may be worn for some time and the knee massaged. In case of habitual dislocation also, use is made of massage and an elastic knee-cap. In all recent cases in which reposition of the cartilage is not successful, in old cases, and in cases of habitual dislocation, an operation should be performed if the disturbances are marked—that is, the cartilage should be sutured in place again or removed. H. Allingham has described in detail nine cases of removal of the semilunar cartilage and twelve cases of suture of the same, taken partly from his own experience and partly from the literature of the subject. The results following removal of the cartilage are very good.

Internal Derangement of the Knee Joint.—This term is applied to a condition of the knee which occurs as the result of a traumatism that has taken

place some time before. In a case reported by Delorme the knee gave a sort of jump just before the end of extension. The patient experiences a painful vibration or an audible crackling in the knee. The movement of the joint—e. g., the end of extension—is not arrested, but is often retarded. The causes of this condition are sometimes not clear, but in many cases there is probably a displacement and incarceration of a torn semilunar cartilage (see page 759) or a muscular contraction.

§ 331. **Dislocations of the Patella.**—The patella is a sort of sesamoid bone within the quadriceps tendon. This tendon is therefore displaced in every dislocation of the patella, with or without injury of the same. The dislocations of the patella have been described in detail, particularly by Malgaigne and Streubel, and following them we distinguish these forms :

1. **Dislocation of the Patella Outward or Inward.**—In complete outward or inward dislocation the patella is displaced entirely to one side of the involved condyle. In incomplete dislocation the patella is displaced only so far to one side that its inner or outer border projects somewhat beyond the edge of the condyle.

Outward dislocation of the patella (Fig. 837) is by far the most frequent form, because the articular surface of the outer condyle is not so broad nor so high as that of the inner condyle. In addition to this, the patella lies normally nearer to the outer condyle of the femur on account of the oblique position of the femur, or, in other words, the slight valgus position of the normal knee joint. Thus is explained why in genu valgum an outward dislocation of the patella occurs rather frequently (Malgaigne, Hueter).

Outward dislocation of the patella occurs usually when the knee joint is extended, sometimes from direct violence and sometimes as the result of sudden and forcible contraction of the quadriceps muscle, in consequence of which the patella slips outward above the articular surface of the femur. The dislocation occurs less frequently from direct violence when the knee joint is flexed.

The symptoms of an outward dislocation of the patella are especially distinct in case of its complete dislocation upon the outer surface of the external condyle. If the swelling is slight, the patella can usually be easily felt in the above location, while it is absent at its normal place. The tense tendon of the quadriceps muscle and the ligamentum

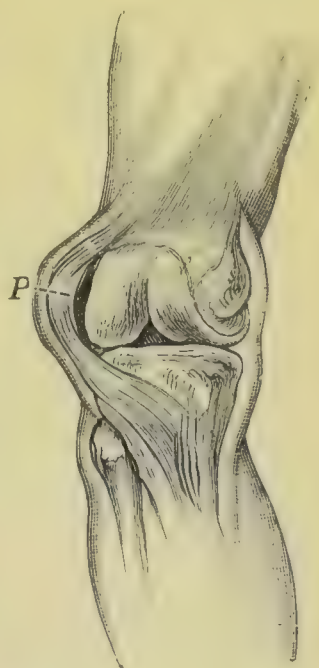


FIG. 837.—Complete dislocation of the patella outward.

patellæ are very prominent. The joint is broadened and is slightly flexed. It is immovable actively, and passive movement is very limited and attended with severe pain. In incomplete dislocations of the patella the symptoms are less distinct, but here also one can distinctly feel, upon careful examination, that the outer edge of the patella has been displaced outward and projects beyond the external condyle.

Dislocation of the patella inward can scarcely occur, according to the investigations of Meyer and Danneger, as a complete dislocation, because the patella does not find a sufficient hold upon the rounded articular surface of the condyle, but is immediately drawn back into its normal place by muscular traction. The shortness also of the quadriceps tendon and of the ligamentum patellæ scarcely allows a displacement of the patella over the inner condyle, and rupture of the tendon or ligament is more likely to occur (Streubel). If, however, the ligaments of the knee joint are relaxed, a complete dislocation of the patella upon the lateral surface of the inner condyle may occur without rupture of the ligamentum patellæ or the quadriceps tendon. The symptoms of a complete or incomplete inward dislocation can readily be inferred from what has been said.

2. Vertical Dislocation of the Patella.—This form of dislocation, in which the patella is rotated about its long axis, is rare. Among one hundred and twenty cases of dislocation of the patella Streubel found twenty-one that were vertical. In vertical dislocation of the patella one of its edges rests against the middle of the articular surface of the femur, and the other lies directly beneath the skin. If the cartilaginous surface of the patella is directed inward, such a dislocation is called an inward vertical, and if directed outward it is an outward vertical dislocation. Vertical dislocations arise usually from the action of direct violence (thrust, blow) upon the outer or inner border of the patella, and also from contraction of the quadriceps muscle when the leg is abducted or adducted and somewhat rotated. In consequence of the tilted position of the patella, the capsule is usually considerably torn. The dislocated patella is fixed in its abnormal place by the elastic tension of the lateral ligaments, and also, perhaps, by the impaction of the edge of the patella into the cancellous tissue of the femur.

The symptoms are very characteristic. The sharp edge of the patella projecting beneath the skin is distinctly visible. It can be ascertained in what direction the cartilaginous surface points by feeling the vertical ridge of the latter, while the outer bony surface of the patella is smooth. Moreover, in the inward vertical dislocation the tendon of the quadriceps forms a prominence with its convexity inward on the inner side of the joint, whereas in the outward vertical disloca-

tion precisely the reverse is true. Active movement of the knee joint is impossible, while passively the movements are very much restricted and attended with severe pain.

3. **Complete Reversal of the Patella**, so that the cartilaginous surface lies beneath the skin, is only possible when the capsule is extensively torn on both sides. Hoffa mentions cases of this kind observed by Gaulke, Wragg, Castaro, and Watson. The diagnosis of these very rare dislocations is made by feeling the vertical ridge of the posterior surface beneath the skin.

4. **Displacement of the Patella Upward**, in consequence of avulsion of the ligamentum patellæ at its insertion or in consequence of rupture in its continuity, should not be counted among the dislocations. The treatment consists in aseptic suture of the severed ligament or of the quadriceps tendon.

5. **Dislocation of the Patella between the Condyles of the Femur and the Tibia**, in consequence of avulsion of the tendon of the quadriceps muscle, so that the lower edge of the patella is directed forward, was observed by Midelfart, L. Szuman, and C. Deaderick. Midelfart and Szuman effected reduction by means of an operation.

The prognosis of lateral dislocations of the patella is, generally speaking, favourable, but that of vertical dislocations in consequence of extensive rupture of the capsule and the lateral ligaments is less so. After successful reduction the function of the knee joint becomes restored, as a rule, though there often remains a tendency to recurrence. In unreduced dislocations of the patella the gait of the patient is usually insecure, and flexion and extension are generally interfered with. The mobility of the knee is restricted the most in unreduced vertical dislocation and in complete reversal.

Treatment of Dislocations of the Patella.—In the reduction of all dislocations of the patella the quadriceps tendon should be relaxed as completely as possible by flexion of the hip and extension of the knee. In lateral dislocation the patella can generally be pushed back into its normal place without the use of an anæsthetic, and in vertical dislocation likewise direct pressure is usually sufficient. If in vertical dislocation this method is not successful, the following course is adopted: The patient is anæsthetized and the rent in the capsule is somewhat enlarged by slight flexion of the knee joint; the leg is then rotated in a direction opposite to that toward which the cartilaginous surface of the patella is directed, and the attempt is made to bring the latter into its normal position by direct pressure. In compound dislocations with extreme laceration of the soft parts, removal of the patella may be indicated. The function of the quadriceps muscle or of the knee joint is not seriously impaired thereby. In case of subperiosteal removal of

the patella its regeneration, to a certain extent, by a new growth of bone has been observed. In vertical dislocations that are irreducible on account of the twisted and tense capsule (Streubel) the patella should be exposed and the obstacle removed. In old unreduced dislocations also one will, if necessary, effect reduction by means of an operation, and the same is true of habitual dislocations if the disturbances are marked (Roux). Habitual dislocations, with enlargement of the capsule, have been treated by excising a portion of the latter or making a fold in it.

Congenital Dislocations of the Patella are very rare. They are exclusively outward dislocations. Bessel-Hagen has described three such cases, and has collected thirteen others from literature. Three forms may be distinguished: 1. Incomplete dislocations in which the patella returns to its normal place upon flexion of the joint. 2. Complete dislocations in which the displacement occurs during flexion. 3. Complete dislocations in which the displacement is increased during flexion and is not overcome by extension. The function of the knee joint may become more and more impaired, especially in the latter form of complete dislocation. The malformation was observed in some cases in several members of the same family. The patella is not infrequently rudimentarily developed in cases of congenital dislocation.

In very rare cases the patella is wanting, and the mobility of the knee joint may then be restricted to a marked degree. The absence of the patella or its rudimentary development has been observed also in connection with congenital dislocation of the knee or congenital dislocation, complete or incomplete, of the hip (Krönlein, B. Schmidt, Brunner).

§ 332. **Dislocations of the Fibula at the Upper Tibio-fibular Joint** are very rare. The fibula may be dislocated forward or backward.

In forward dislocation the head of the fibula rests beside the tuberosity of the tibia, and can be felt in this abnormal place. Hirschberg collected nine cases of this dislocation from literature, more of which arose from indirect violence—e. g., from a sudden fall—than from direct violence. In the indirect form of dislocation the violent contraction of the muscles arising from the anterior surface of the fibula (extensor communis digitorum, extensor hallucis longus, and peroneus longus) plays, no doubt, an important part. The reduction of the dislocation is effected with the foot and leg flexed by direct pressure upon the head of the fibula.

The very rare dislocation of the fibula backward arises usually, according to Malgaigne and Dubreuil, from violent contraction of the biceps muscle. The head of the fibula can be felt beneath the skin behind the outer tuberosity of the tibia. Direct pressure upon the dislocated head with the knee joint sharply flexed sometimes causes reduction, but an anæsthetic is often required.

In order to secure the head of the fibula in position and prevent a recurrence, the application of a plaster splint is to be recommended. In dislocation of the fibula forward this should be applied with the joint extended, and in backward dislocation the joint should be flexed so as to relax the biceps muscle. The plaster splint is also of use in immobilizing the knee

joint, which is often more or less involved. After about a fortnight massage and passive exercise are begun.

§ 333. **Fractures of the Lower End of the Femur.**—We distinguish here also, much as in fractures of the lower end of the humerus: 1, Transverse fractures above the condyles of the femur and separations of the epiphysis; 2, oblique fractures just above the condyles; 3, T-shaped (Fig. 838) and Y-shaped fractures; 4, fractures of one or both condyles; 5, comminuted fractures; 6, various incomplete fractures, especially longitudinal fissures penetrating the knee joint.

Etiology.—If we leave out of account direct fractures from a blow, a gunshot wound, or from being run over, the transverse and oblique fractures above the condyles of the femur occur most frequently from a fall upon the flexed knee or upon the feet, or from violent movements of the knee joint, especially hyperextension, lateral flexion, and forcible rotation. The traumatic separations of the epiphysis among young persons up to about the twentieth year occur usually from lateral flexion of the knee joint, and the same is true of fractures of one condyle, with avulsion of the lateral ligament. Tubby has recently described twenty-three cases of separation of the epiphysis with specimens. The age of the patients varied from one and a half to twenty years, the average being thirteen and a half years. The injury was almost always caused by indirect violence in the form of a forcible bending or twisting of the leg. In case of violent inward rotation of the thigh, a transverse fracture of the posterior portion of the inner condyle of the femur may result from traction of the posterior crucial ligament. A similar fracture of the outer condyle of the femur results from traction of the anterior crucial ligament (H. Braun). The T-shaped and Y-shaped fractures are due also, according to Madelung, to the fact that the condyles are forced apart by the patella acting as a wedge, much in the same way as the olecranon fractures the lower end of the humerus. That these fractures do not always arise in this way is shown by those cases in which the patella was absent. Fissures extending into the knee joint frequently occur in connection with fractures of the lower end of the femur, especially gunshot fractures. Isolated longitudinal fissures running upward from the knee joint arise usually from a fall upon the knee or upon the feet. They are sometimes combined with crushing of the femur and the tibia, so that they are strikingly broadened.



FIG. 838.—T-shaped fracture of the lower end of the femur caused by a fall upon the knee (Bruns).

The symptoms of the different forms of fracture of the lower end

of the femur that have been mentioned vary according to the nature of the fracture. The deformity is much the same in transverse fractures above the condyles and separations of the epiphysis as in forward dislocation of the tibia, because the upper fragment of the femur is displaced toward the popliteal space and the lower fragment is displaced forward and upward with the tibia, in consequence of the traction of the quadriceps muscle or the ligamentum patellæ. The vessels and nerves of the popliteal space may easily be injured by the upper fragment. Less frequently the opposite displacement exists, much as in backward dislocation of the tibia. The differential diagnosis between dislocation and fracture can usually be easily made, inasmuch as the abnormal mobility and crepitus above the joint, the absence of fixation of the knee joint, and the easy correction of the deformity by traction are sufficient evidence of fracture. Some of the transverse fractures are impacted fractures.

The deformity is much the same in oblique as in transverse fractures—that is, the fragments lie either in front of or beside one another.

The T-shaped and Y-shaped fractures are partly intracapsular (Fig. 838), and are therefore characterized by a marked effusion of blood into the joint. The lower end of the femur is divided into two fragments by the line of fracture between the condyles which runs into the joint. The separation of the condyles is either incomplete, in the form of a fissure, or it may be complete, and the tibia can then be impacted between the condyles, that are forced apart. The knee joint is strikingly broadened in such cases.

In isolated fracture of a condyle there is either no displacement—e. g., when the periosteum and the crucial ligaments remain intact—or the fragment is displaced upward with the leg, so that in fracture of the outer condyle genu valgum results, and in fracture of the inner condyle a varus position, much as in incomplete lateral dislocation of the tibia. As was mentioned on page 765, the fracture sometimes involves only the posterior portion of the condyle.

Fractures of the lower end of the femur are sometimes combined with those of the upper end of the tibia (see page 767).

The existence of fissures can sometimes be determined by percussion of the bone, according to the method of Luecke and Hueter. They are recognised by the sensation of pain on the part of the patient.

The prognosis is best in the extracapsular transverse and oblique fractures above the condyles. In all fractures involving the joint the restoration of the normal function of the knee is doubtful. Even simple fractures of the joint may result in arthritis deformans, ankylosis, and permanent deformity

of the knee. Disturbances of growth are especially to be feared after separations of the epiphysis. Pseudarthrosis has been repeatedly observed, especially in connection with fractures of the condyles--e. g., from interposition of the torn capsule (Trendelenburg). The prognosis of compound fractures is much more favourable than formerly, owing to the adoption of aseptic methods in the treatment of wounds.

Treatment of Fractures of the Lower End of the Femur.—The deformity is overcome by traction and counter-traction, and by direct pressure upon the displaced fragments. If marked swelling exists, the extremity is placed at the outset in a well-padded Bonnet's wire splint (see Principles of Surgery, page 205, Fig. 172), upon a wooden splint, or a Volkmann splint. An ice bag is applied, if necessary, to allay pain or reduce the swelling. After the swelling has abated, a plaster-of-Paris splint is applied (see Principles of Surgery, page 216 ff.), preferably with the knee slightly flexed, or use may be made of Beely's splint of plaster of Paris and hemp, or, finally, of an extension apparatus (see Principles of Surgery, page 225 ff.). In the latter case the leg at the site of fracture may be incased in a short plaster-of-Paris splint. The apparatus described on pages 731–733, Figs. 816–818, are also very useful. The plaster-of-Paris splint is to be renewed as soon as it becomes loose—after two or three weeks, at all events. Bryant recommended tenotomy of the tendo Achillis for the relaxation of the gastrocnemius muscle, in order to overcome in transverse fractures the tendency of the lower fragment to backward displacement. After the six or eight weeks required for the union of the fracture, the stiffness of the knee joint is to be overcome by massage, baths, active and passive exercise, etc. As regards ambulatory appliances in connection with fractures of the lower extremity, see page 733 (Fractures of the Thigh).

In case the displacement of the lower fragment—e. g., in fracture of the condyles or separation of the epiphysis—can not be overcome or easily recurs, one may prevent malunion of the fracture by aseptic nailing of the fragments. Compound fractures are treated with a strict observance of antiseptic precautions and according to general rules (see Principles of Surgery, pages 594–601), as are any injuries of the large vessels and nerves of the popliteal space (ligation, neurorrhaphy, etc.). In case of extensive injuries of the soft parts or severe crushing of the femur, amputation of the thigh may be indicated.

§ 334. **Fractures of the Upper End of the Tibia.**—These fractures are not frequent. We distinguish fissures, avulsion of a portion of the articular surface by the crucial ligaments, transverse and oblique fractures, comminuted fractures, separation of the epiphysis, and fracture

of a tuberosity, more frequently the inner tuberosity, because the latter supports a heavier load than the outer one in walking and standing.

Fractures of the upper end of the tibia arise sometimes from direct and sometimes from indirect violence, such as a fall upon the feet, or rotation and lateral flexion of the knee joint—e. g., during delivery in case of difficult ex-

traction or version. Impacted fractures also are caused usually by a fall upon the feet, the lower fragment forcing its way into or between the two tuberosities and separating them (Fig. 839). In place of fracture of the upper end of the tibia from a fall upon the feet, fracture of a tuberosity often takes place most frequently of the inner

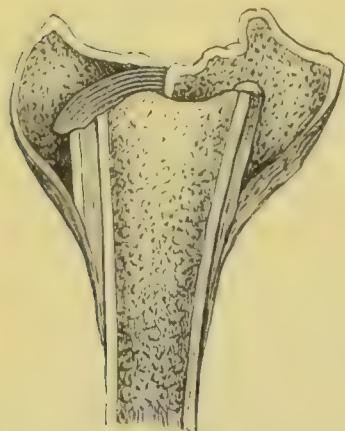


FIG. 839.—Impacted fracture of the upper end of the tibia.



FIG. 840.—Fracture of the inner tuberosity of the tibia, with considerable crushing (Wagner).

one (Fig. 840). In other cases of fracture of the tuberosities of the tibia there is not so extensive a crushing, but a simple linear division, as, for example, in Fig. 841.

As regards diagnosis, the effusion of blood into the knee joint (hæmarthros) and the pain and deformity at the site of the fracture are particularly important. The superficial location of the bone renders it easy to make out the abnormal mobility and crepitus. The swelling may, however, be so great as to make an exact determination of the fracture difficult. In case of fissures, the bone is strikingly painful on percussion. The symptoms attending crushing fractures of the upper end of the tibia and also of the inner tuberosity are, as a rule, thoroughly characteristic. In these fractures the knee is slightly flexed, the leg and foot are adducted (*genu varum*), the inner condyle is prominent and pressed downward, as it were (Fig. 840), and very tender; there is a marked effusion of blood within the joint, and the lateral mobility of the latter is increased. The symptoms are not so distinct in milder cases, but here also there are a thickening and prominence of the inner condyle, which is tender on pressure.



FIG. 841.—Linear fracture of a tuberosity of the tibia.

In separations of the upper epiphysis of the tibia, of which Tubby has recently described several cases with two specimens, there is usually only a slight backward displacement of the epiphyseal fragment.

The prognosis of all intracapsular fractures of the upper end of the tibia is doubtful, as a rule, as regards the restoration of the normal movement of the joint. There may follow union with good use of the knee joint, but in other cases its function is seriously impaired. As is well known, arthritis deformans easily ensues after all intra-articular fractures. Disturbances of growth are to be feared among young persons after separation of an epiphysis in consequence of premature ossification. The prognosis is always more favourable, of course, in extracapsular fractures.

The treatment of fractures of the upper end of the tibia is essentially the same as that of fractures of the lower end of the femur (see page 767). The extension apparatus (see Principles of Surgery, page 225 ff.) is here also, generally speaking, the best form of treatment. An ice bag is applied to the knee, if necessary, and the absorption of the blood in the joint is hastened later by elastic compression and massage. Aseptic puncture, with or without antiseptic irrigation of the joint, is very rarely necessary. After ten days or a fortnight, when the swelling has disappeared and the fragments are in good position, the extension apparatus may be exchanged for a plaster-of-Paris splint. Union ensues in simple fractures in from six to eight weeks. An effort is then made to restore the function of the muscles, and, above all, the mobility of the joint by massage, active and passive exercise, and electricity. As regards ambulatory splints in connection with fractures of the lower extremity, see page 733 (Fractures of the Thigh).

Compound fractures are treated aseptically and according to general rules (see Principles of Surgery, pages 594–601).

If the use of the knee joint is impaired by malunion of the fracture, an effort should be made to improve its condition by osteotomy of the tibia or resection of the knee.

Avulsion of the tubercle of the tibia is of rather rare occurrence, and arises from violent contraction of the quadriceps muscle or traction of the ligamentum patellæ. It occurs frequently in jumping, and is most common among young persons, in whom the tubercle has not complete bony union with the tibia. The fragment is usually displaced upward by traction of the quadriceps muscle. The fracture is characterized by the presence of a movable fragment of bone at the place of insertion of the ligamentum patellæ or beneath the patella, which is displaced upward, answering to the displacement of the tubercle. Crepitus can be easily made out. Extension of the leg is interfered with. There is a bursa between the ligamentum patellæ and the tibia, which is separated from the knee joint by a thin membrane. If this septum is ruptured, the knee joint is opened, and there is then usually

an effusion of blood within the same. With suitable treatment bony union follows. In cases which are not suitably treated or not treated at all, walking may be possible only with a cane and a knee-cap (Pitha).

The treatment consists in fixation of the broken-off fragment of bone in its normal place by the use of strips of adhesive plaster or by an aseptic nail. A plaster-of-Paris splint is then applied with the knee joint extended, and the extremity is given an elevated position for from four to six weeks. Pseudoarthrosis is most surely avoided in this way.

Fractures of the Upper End of the Fibula.—The head of the fibula is seldom broken off. It occurs, for example, from traction of the biceps muscle when a person is upon the point of falling and braces himself forcibly upon the extremity. Fractures of the upper end of the fibula also result from direct violence. The diagnosis can usually be made from the localized pain, the swelling, and the abnormal mobility and crepitus in the region of the head of the fibula. The most important complication is injury of the peroneal and the external cutaneous nerves, sometimes from the action of the violence itself, sometimes supplementarily by the fragments or splinters of bone. Pain and disturbances of sensation, especially above the inner malleolus and the dorsum of the foot, as well as paralysis of the muscles on the anterior and outer side of the leg, may arise later from pressure of the callus upon the peroneal nerve. Tubby speaks of a case of separation of the upper epiphysis of the fibula in a child one and a half years of age.

The treatment of fractures of the head of the fibula and of the upper end of the fibula in general consists in reposition of the fragment that is broken off and in its fixation by means of a plaster-of-Paris splint. If the fracture is complicated by division of the peroneal nerve, the latter should be sutured at once. Defects in the nerves are treated according to general rules (see § 295, page 606). In case of paralysis of the peroneal nerve from the pressure of the callus, the latter should be removed. Resection of the head of the fibula is indicated in comminuted fractures.

§ 335. **Fractures of the Patella** are not very common. They amount, according to P. Bruns, to about 1·3 per cent of all fractures. There are essentially two principal types to be distinguished: 1. Transverse fractures from muscular action. 2. The stellate, oblique, longitudinal, or transverse fractures arising from direct violence. Chaput has experimentally determined the etiology of fractures of the patella. He distinguishes, in addition to direct and indirect fractures, those which are caused by the simultaneous action of both kinds of violence ("mixed fractures").

Transverse Fracture of the Patella.—This form of fracture is by far the most frequent, and, as has been said, may be either direct or in-

direct. In the latter case it is the result of muscular action, and often occurs when a person is in danger of stumbling and falling, and with bent knee makes a violent effort to hold his body erect which is falling backward or to the side. The patella in such a case is fractured transversely against the condyles, just as a piece of wood is broken over the knee. Direct transverse fractures are caused by a fall upon the bent knee, which fractures the unsupported lower part of the patella. According to Howe, Hamilton, and others, most transverse fractures are direct. Incomplete fractures are rare. We have mostly to deal with complete fractures, which are usually found in the middle or, it may be, near the upper and the lower border. Aside from the bone, the aponeurosis likewise and the capsule, to a variable extent, as well as the fibrous connective tissue at the side of the patella, are torn. The skin is intact in indirect fractures. In exceptional cases the tubercle of the tibia is torn away by traction of the ligamentum patellæ (see page 769). The patella is occasionally refractured either at or near the former site of fracture, most commonly through the lower fragment.

The symptoms of a transverse fracture of the patella are, as a rule, very distinct, so that the diagnosis is easy. The separation of the fragments is marked, especially in case of extensive rupture of the aponeurosis and the fibrous portion of the capsule on both sides of the patella. By grasping the upper and lower border of the patella and moving the fragments, the abnormal mobility and crepitus are easily made out. If the periosteum and the lateral portions of the capsule are not divided, the displacement of the fragments is slight or may be completely absent. The effusion of blood in the joint varies in amount. The patient is unable to elevate his leg, in consequence of the relaxation of the quadriceps muscle.

The prognosis of fractures of the patella depends upon the amount of separation of the fragments or upon the extent of the tear in the capsule and, above all, upon the treatment. The greater the separation, the more likely is pseudarthrosis to take place, with impairment of the ability to walk. In the cases where the capsule is not torn at all or only very slightly and the separation of the fragments is accordingly slight, bony union and the ability to walk well are easily secured. The development of pseudarthrosis is favoured also by the interposition of a fringe of the torn aponeurosis between the fragments (Macewen, König, Hoffa). If the fracture heals by fibrous union, this may be so compact that no cleft can be felt between the fragments, and the latter can not be moved on one another. In such cases bony union may still follow later on. In other cases the fragments are united by a fibrous band from two to six centimetres or even more in length. The more movable the fragments, and the greater the amount of separation, so much the greater is the interference with the function of the leg. There is frequently no fibrous connection at all between the fragments, and in such

cases walking is usually very seriously affected. Aside from the separation of the fragments, the disability of the leg is also conditioned in part upon atrophy of the quadriceps muscle and upon adhesion between the upper fragment and the anterior surface of the femur (P. Bruns). For this reason the function of the leg can often be decidedly improved simply by massage of the muscles of the thigh. Among twenty-five cases collected by Brunner, in which secondary suture was employed on account of the poor function of the leg, all intermediate tissue was wanting in ten cases, in seven cases there had been a refracture, and in five cases the fragments were adherent to the femur. Bony union and the ability to use the joint well in walking have frequently been secured of late by the use of improved methods of treatment. In the case of a man seventy years of age, who fractured the patella twice, I secured bony union in a short time in each instance.

Treatment of Fractures of the Patella.—Numerous methods have been recommended for the treatment of transverse fractures of the patella. The mode of treatment depends mainly, in recent cases, upon the amount of separation of the fragments or the extent of the tear in the capsule. In case the separation is marked, suture of the fragments is indicated (see page 773). In case it is slight, bony union is often easily secured by the following method: After any marked effu-

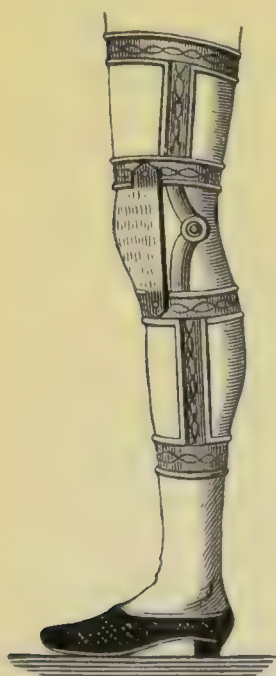


FIG. 842.—Splint for the after-treatment of fractures of the patella.

sion of blood that may exist has been removed by massage, and the fragments brought together as far as possible by the use of strips of adhesive plaster, a light plaster-of-Paris splint is applied, with the knee extended, which reaches from the upper third of the thigh to the neighbourhood of the malleoli. While the plaster-of-Paris bandage is hardening, it is pressed in on all sides around the two fragments, so that the latter are surrounded by a distinct depression in the splint and are immobilized with their edges in close coaptation. The patient walks about in this splint, which is to be renewed every eight or ten days. Each time that the splint is changed the knee and the quadriceps muscle are massaged to prevent atrophy of the latter. If the separation of the fragments is slight or is absent altogether, it is not necessary to inclose the whole leg in a plaster splint, but in its place a simple leather, plaster, or water-glass posterior splint may be used, which can be easily removed.

The patient should be allowed to walk about, and the knee and the thigh muscles are massaged every day. At night also the joint is kept fixed in an extended position. In employing massage, one should knead and beat the quadriceps muscle, and press the upper fragment

of the patella downward as far as possible with the left hand. As long as the fragments are united by young, easily stretched tissue, attempts to move the knee should be undertaken with great caution. The patient should be made to wear for six to eight weeks some sort of splint to prevent full flexion of the knee.

It has been properly stated that the approximation and bony union of the fragments are principally prevented by a large effusion of blood

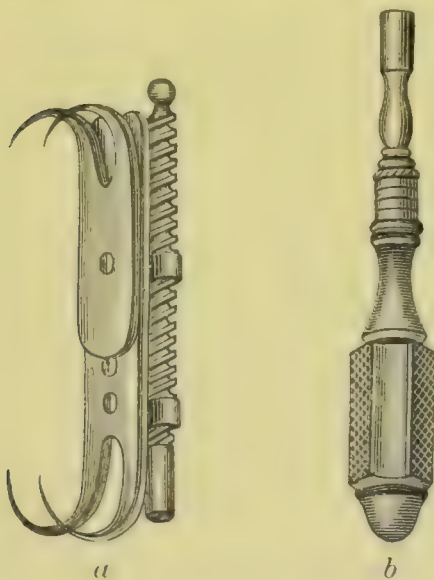


FIG. 843.—*a*, Malgaigne's hooks with a screw key (*b*) for transverse fractures of the patella.

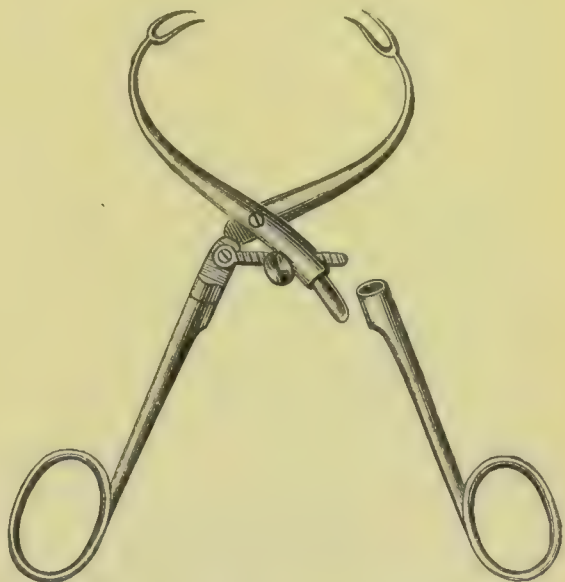


FIG. 844.—Ollier's adjustable hook-forceps for transverse fractures of the patella.

within the knee joint. Aseptic puncture and irrigation of the knee joint have therefore been recommended. This is, however, altogether unnecessary. The removal of the blood is much more simply accomplished by elastic compression of the joint by means of rubber bandages and by massage. The blood is pressed in this way into the tissue clefts of the thigh, since the joint is usually opened subcutaneously.

Various devices have been employed for holding the fragments together. Malgaigne's hooks (Fig. 843) are scarcely used any more at present. One hook is forced into the upper fragment and the other into the lower, under aseptic precautions, and then brought together by means of the screw. A closely fitting plastic splint of gutta-percha or cellulose may also be applied above the fragments and another below them, the hooks inserted into these, and the fragments thus approximated indirectly. Ollier's hook-forceps act in the same way (Fig. 844).

The best method of fixing the fragments is by aseptic suture, which gives excellent results. This is indicated principally in compound fractures, in simple fractures with marked separation of the fragments which can not be overcome in any other way, and in old fractures

in which bony union has not taken place and which are attended with marked functional disability of the knee. Only a surgeon who is a thorough master of asepsis should attempt this operation. In recent cases of simple fracture one should not, as a general rule, suture the fragments. Suppuration of the knee joint has occurred in cases where the operation was not performed aseptically. There are various methods in use. One method consists in exposing the fracture by a transverse incision, removing the blood that is found in the joint by the use of aseptic gauze pads, cutting away any of the aponeurosis that may be interposed between the edges of the fragments, boring through the edges of the bone with a drill, and uniting the fragments by one or two sutures (silver wire, catgut, silkworm gut). Then follow drainage of the joint, suture of the external wound, the application of an antiseptic dressing, and immobilization of the joint in a Volkmann splint. Subcutaneous suture is less dangerous, which consists in boring directly through the skin and the fragments with the drill, and then tying the inserted silver-wire or silkworm gut over a small roll of iodoform gauze. Ceci bores through the fragments in a diagonal direction, and ties the silver wire together in the form of an 8. The substitution of silk threads through the quadriceps tendon and the ligamentum patellæ is preferable to suture of the bone. Volkmann passes a silk thread transversely through the tendon of the quadriceps muscle and one through the ligamentum patellæ, and ties the ends together, while an assistant brings the fragments into exact coaptation. Then follow the application of an antiseptic protective dressing, a plaster-of-Paris splint, and removal of the sutures in about three weeks. Kocher passes a stout curved needle armed with a double silver wire under the patella from below upward. The needle is introduced at the lower border of the lower fragment, carried upward beneath the cartilaginous surface of both fragments, and brought out above the upper border of the upper fragment. The double silver wire is tied over a roll of gauze. To avoid the formation of a fold in the skin, an incision about two centimetres long is made, through the skin only, at the point of entrance and exit of the needle. Andersson's method is also worthy of recommendation. He inserts two stout steel needles through the solid prepatellar aponeurosis, one above and one below the line of fracture, without penetrating the bone or the joint. The needles are then drawn toward each other, and the fragments thereby well approximated. The needles are held together on one side by sticking them through a cork, and on the other by winding wire about them.

Old fractures of the patella without bony union and with marked separation of the fragments and functional disability of the knee joint may be

sutured after freshening the fragments. Legan, Trendelenburg, Smith, and the author have secured good results in this way. The approximation of the fragments is often, however, attended with difficulties. In order to make the lower fragment more movable one may, after Bergmann, chisel away or saw away the tubercle of the tibia obliquely with the ligamentum patellæ. Sonnenburg and the author have operated in this way likewise with good results. The upper fragment can be drawn down nearer the lower one by making several gaping incisions in the quadriceps muscle (Macewen).

In other cases where the patient is averse to an operation an effort should be made to improve the functional ability of the leg—e. g., by use of the splint with an elastic knee-cap for the region of the patella, which is represented in Fig. 842, page 772, and also, above all, by massage, particularly of the quadriceps muscle.

The statistics prepared by Brunner (1885) and Dennis (1886) with reference to suture of the patella are very instructive. Of eight cases treated by Kocher's method of suture of the quadriceps tendon and the ligamentum patellæ, one terminated fatally and two resulted in suppuration of the joint. Of forty-five cases of primary suture of the bone, the majority healed aseptically. Suppuration of the joint resulted in eight of these cases and necrosis of the fragments in two. Amputation of the femur was necessitated in two of them on account of suppuration and pyæmia, and two cases ended fatally. As regards the functional result, thirteen cases were completely successful, and ankylosis ensued in seven. Dennis's statistics, covering one hundred and eighty-two cases, gave seventy-five good results, thirty-five that were satisfactory, and twenty-four that were bad. Eleven cases terminated fatally, suppuration of the joint occurred in thirty-four, amputation of the thigh was necessary four times, and there were seventeen cases of partial and fourteen of complete ankylosis. Among forty-five old fractures of the patella which were treated by suture of the bone, suppuration of the joint occurred, according to Brunner, in eleven cases, three cases terminated fatally, there was one amputation of the thigh, ankylosis ensued in seven cases, and in others the movement of the joint was more or less restricted. All these statistics are of great interest. They teach us that suture of the tendon and ligament or the bone should be performed only in case of necessity, when other methods of securing coaptation of the fragments do not accomplish the purpose. The more recent results of this operation are doubtless much better, owing to the improved aseptic methods. Trendelenburg has, for example, performed suture of the patella twenty-four times in the past ten years, and with excellent functional results.

The other fractures of the patella—the longitudinal fractures, the oblique fractures, or multiple fractures (stellate fractures, comminuted fractures)—arise chiefly from direct violence—e. g., from a blow, a fall, or a gunshot injury. They are frequently combined with a wound of the skin—that is, are compound fractures. If there is no displacement of the fragments, a simple fracture can easily be overlooked when there is a marked effusion of blood. Bony union almost always takes place, because there is, as a rule, no separation of the

fragments. The compound fractures combined with opening of the knee joint are the most unfavourable. They must be treated under strict observance of antiseptic details (see Principles of Surgery, pages 597 and 726).

The treatment of simple fractures in which there is no displacement consists in applying a plaster-of-Paris splint for a fortnight, or a shorter time even, and then allowing the patient to walk about with a splint. Massage is then employed, as described on page 772. Fractures with separation of the fragments are treated in the same way as transverse fractures (see page 772).

Compound fractures are treated under antiseptic precautions and according to general rules. The removal of the patella may be indicated when there is extensive injury of the soft parts or in case of comminuted fracture. No functional disturbance of the quadriceps muscle or of the knee joint follows the removal of the patella if the wound heals normally. After subperiosteal removal of the patella the latter may be, to a certain degree, regenerated.

§ 336. **Penetrating Wounds of the Knee Joint** led very frequently, before the adoption of antiseptic methods, to suppurative and septic inflammations of the joint. Their prognosis has been very much improved under the antiseptic method of treatment. Small wounds often close spontaneously by primary union, and if no microbes gain access to the joint with the instrument that inflicts the injury or afterward, complete return to the normal follows even without antiseptic treatment of the wound. Every penetrating wound of the knee joint is, nevertheless, to be regarded as a serious injury which is to be treated with the greatest care. The wounds of the knee joint which are complicated by injury to the bone, especially gunshot wounds, are the most unfavourable.

Gunshot wounds of the knee joint sometimes involve no injury to the bone, especially the transverse wounds through the upper part of the capsule and in the region of the ligamentum patellæ. Simon showed that wounds of the joint without injury to the bone are also possible if the knee is slightly flexed at an angle of 130° to 170° , and the ball enters in a sagittal direction below the patella, through the ligamentum patellæ or laterally from it, and makes its exit in the popliteal space, passing through the crucial ligaments and the intercondyloid fossa. If a knee joint is injured when flexed, and is then extended, the superficial wound no longer communicates with the wound in the capsule owing to the displacement of the skin, but the latter wound is covered by intact skin. This fact is important from a prognostic standpoint, because a subsequent infection of the joint is

made difficult or is prevented by this closure of the wound in the capsule. In most cases the bone is likewise injured in gunshot wounds of the knee joint, either in the form of a groove or a complete hole in the bone, or the latter is extensively comminuted. There are frequently only fissures of the bone which may give rise to a suppurative inflammation of the knee joint even in the case of extracapsular gunshot wounds of the femur or the tibia. The ball not infrequently remains embedded in the bone or lies free in the joint.

The clinical course of every wound of the knee joint depends upon whether or not micro-organisms gain entrance to the joint at the time of the injury or afterward. If no infection of the joint occurs, the wound closes by primary union, the escape of synovial fluid ceases, and no functional disturbance of the joint results.

The course of an infected wound of the knee joint is altogether different. The symptoms of an acute inflammation of the joint occur here either immediately—e. g., within the first twenty-four hours—or not until the third to the fifth day—that is, the joint swells and becomes painful, and the skin is reddened and hot. There is a high temperature, frequently preceded by a chill. The course is sometimes less acute. The infection of the joint is either an immediate consequence of the wound, or it arises secondarily—e. g., from improper treatment, the use of unsterile probes, or from reckless behaviour on the part of the patient, who pays no attention to the wound, walks about with it, etc.

In one class of cases suppuration does not take place, and the local symptoms of inflammation and the fever abate. In other cases, on the contrary, an acute suppurative inflammation of the knee joint develops more or less quickly, which is characterized by severe pain, marked swelling and pronounced functional disturbance of the joint, and by high fever, which often begins suddenly with a chill. Acute suppurative inflammation of the knee joint terminates less frequently in a return to the normal, oftener in recovery, attended by partial or complete ankylosis, or, finally, in death from pyæmia and septicæmia, if prompt operative treatment is not energetically begun (drainage, resection of the knee, amputation of the thigh). The worst cases result in acute septic inflammation of the joint, sometimes with gas formation, and death from general sepsis may ensue very quickly.

Tetanus has been observed especially after gunshot wounds which were soiled with earth (see Principles of Surgery, page 354 ff.). Generally speaking, the course of an infected wound of the joint depends upon the nature of the infection or of the micro-organisms that have entered it, and also upon whether or not the wound receives suitable antiseptic treatment with sufficient promptness.

For the diagnosis of a penetrating wound of the knee joint the escape of synovia and the location of the injury are of especial importance. If the wound has already closed, one may be in doubt whether the joint has been entered or not, and he should quietly await the further course. In all wounds about the knee joint the use of the probe should be restricted, and, at all events, only probes that are undoubtedly aseptic ought to be employed.

Treatment of Wounds of the Knee Joint.—We shall leave out of consideration at first the treatment of gunshot wounds, and consider only punctured or incised wounds which are not complicated by injury to the bone. In absolutely fresh injuries of the joint the treatment consists in disinfection of the external wound and its surroundings, in the application of an antiseptic dressing, and in complete immobilization of the joint by a splint. Healing often takes place under an antiseptic dressing. The dressing is immediately changed if fever appears and the patient complains of pain. If it is found, upon removal of the dressing, that infection of the joint has occurred, and that suppurative inflammation is already in progress, the joint should be freely laid open, irrigated with antiseptic solutions (1-to-1,000 bichloride), and drained. If, in spite of disinfection and drainage, severe constitutional symptoms show themselves, or if the suppuration is very extensive, either resection of the knee, or, in case general septic or pyæmic infection is threatened, amputation of the thigh is indicated. If suppuration already exists when the patient is brought under treatment, it then depends upon the amount and the duration of the suppuration whether incision and drainage, resection of the knee, or amputation of the thigh, is to be chosen. The incisions should be made over different parts of the joint, including the popliteal region.

The treatment of gunshot wounds likewise conforms to antiseptic principles. The expectant method is adapted, above all, for military practice. In peace, however, this should not be carried too far. The treatment of gunshot wounds consists mainly in arresting the hæmorrhage, in extracting any foreign bodies that have entered the joint (ball, shreds of clothing, etc.), in disinfection and drainage of the wound, and immobilization of the joint by means of a splint. Too zealous and too-long-continued search for the ball is objectionable. The ball may heal in the tissues without causing any reaction. Dementjew and Bergmann observed eighteen cases, in the Russo-Turkish War, in which the ball remained in the knee joint. Sometimes it migrates from here afterward. Bergmann and Reyher made very successful use of the expectant method of treatment in the Russo-Turkish War by restricting themselves to the disinfection of the wound and

its surroundings, and then immobilizing the extremity by means of a plaster-of-Paris splint, with or without an antiseptic protective dressing. In peace, as has been said, the expectant method of treatment will not be carried so far as in military practice. Injuries of the bone are treated under antiseptic precautions and according to general rules (see Principles of Surgery, pages 597 and 732, Treatment of Compound Fractures). Resection of the knee or amputation of the thigh will be performed, depending upon the extent to which the soft parts and the bone are mangled.

§ 337. **Injury and Ligation of the Popliteal Artery.**—Wounds of the popliteal artery are observed especially in gunshot injuries and in connection with fractures and dislocations of the knee joint. Subcutaneous ruptures may also arise from violent movements of the knee joint, if the wall of the artery has become degenerated in consequence of endarteritis, which very frequently occurs here, and beginning aneurism. Poland collected seventy such cases. In forty-two of them there was a tear in an aneurism. Ligation of the femoral artery is preferred by many in wounds of the popliteal artery, on account of the deep location of the latter and possible cicatricial contraction of the knee.

There are two places at which ligation of the popliteal artery can be performed—viz., in the popliteal space and in the so-called Jobert's space, between the adductor magnus and the sartorius and gracilis muscles.

Ligation of the popliteal artery in the popliteal space is performed with the patient lying upon his abdomen and the knee extended. The internal popliteal nerve can be felt in the upper half of the popliteal space as a distinct cord. The skin incision, which is from eight to ten centimetres long, runs down the middle of the popliteal space, answering to the above nerve or somewhat to the inner side of it, along the outer border of the semimembranosus muscle. After dividing the skin, the thick layer of fat, and the popliteal fascia throughout the whole extent of the longitudinal incision, the nerve becomes visible. It is retracted outward, and upon passing in deeper the popliteal vein is found behind the nerve and somewhat to the inner side of it. The artery lies behind and somewhat to the inner side of the vein. The artery and the vein are rather firmly united, and the isolation of the vessels must therefore be performed with great care. It is facilitated if the vessels are somewhat relaxed by flexion of the leg.

For exposing the lower portion of the popliteal and the commencement of the posterior tibial artery, W. Koch suggested an incision a thumb's breadth to the inner side of the head of the fibula, beginning

on a line with the knee joint and extending about ten centimetres downward parallel to the median line. After dividing the skin, the subcutaneous cellular tissue, and the fascia, the lateral border of the outer head of the gastrocnemius muscle appears, which is drawn in-



FIG. 845.—Aneurisms of both popliteal arteries in an apothecary fifty-five years old (Gersuny).

ward and upward, with the knee joint semi-flexed. One now makes his way into a narrow groove filled with fat between the lower border of the popliteus muscle and the edge of the soleus, where the internal popliteal nerve is felt. The popliteal artery lies to the outer side of the nerve and deeper. The vessels are exposed by pushing a grooved director between the soleus muscle and the nerve, and dividing the muscle upon the director.

Ligation of the upper portion of the popliteal artery in Jobert's space between the adductor magnus above and the sartorius and gracilis muscles below, on the inner side of the thigh, is performed with the patient in a dorsal position, with the knee flexed and the thigh rotated outward. The skin and the subcutaneous cellular tissue are divided longitudinally in the middle of Jobert's space between the muscles named and parallel to the sartorius. After the fascia lata has been divided upon a grooved director, the tendon of the adductor magnus muscle becomes visible in the upper

border of the wound and that of the sartorius and gracilis muscles at the lower end. The artery is situated behind the tendon of the adductor magnus muscle, and can be exposed by dividing the fibrous sheath of the latter and retracting the tendon itself upward. The popliteal artery here lies upon the posterior surface of the vastus internus muscle.

Aneurisms of the Popliteal Artery, especially at its point of bifurcation into the anterior and posterior tibial, are rather frequent (Fig. 845). They result sometimes from injuries, more frequently, however, from chronic endarteritis, particularly in connection with syphilis and among alcoholic persons. As at the point of bifurcation of other large arteries into two equally large branches, so here also endarteritis is rather common. In addition to this, it may be that the resistance of the wall of the artery has been reduced by the movements of the knee joint. Boling, Svensson, Temple, and E. Küster observed aneurisms caused by an exostosis of the femur.

Those of the popliteal artery are by far the most frequent of all aneurisms upon the extremities. I saw an aneurism of the popliteal artery in an alcoholic patient forty-five years of age, which had long remained latent and which suddenly gave rise to gangrene of the foot and the leg, so that amputation of the thigh became necessary. The thrombosis extended upward into the femoral artery.

For a more detailed account of aneurisms the reader is referred to page 532 of *Principles of Surgery*. The treatment is there given more fully. Here also, as in aneurisms of the femoral artery (see page 737), one should, in the first place, make use of compression (digital compression, elastic compression by means of rubber bandages, by hyperflexion of the knee joint, etc.). The results of ligation of the femoral artery are uncertain. The surest treatment consists here also in dividing and, it may be, extirpating the aneurismal sac after ligation of the afferent and efferent portion of the vessel and all branches going off from the aneurism (Antyllus). Great care is necessary in dissecting away the sac from the vein. In one case, on account of too firm adhesion between the aneurism and the popliteal vein, Köhler tied the latter in two places and excised it without any bad result. In other cases gangrene of the foot or of the leg has followed ligation of the popliteal vein, which has been wounded in operating upon the aneurism. To avoid the danger of wounding the vein, it is a good plan to extirpate the aneurismal sac only partially and then to pack it. The literature of the subject gives, according to Köhler, fourteen cases of extirpation of popliteal aneurisms by the method of Antyllus which resulted favourably. The prognosis of the operation is more favourable in idiopathic and old traumatic aneurisms than in fresh traumatic aneurisms, because in the latter the establishment of a sufficient collateral circulation is impeded in consequence of the pressure of the surrounding tissue which is infiltrated with blood.

§ 338. **Inflammations of the Knee Joint.**—The acute and chronic inflammations of the knee joint are very common. We shall take up first acute inflammation (acute gonitis), which may be either serous, sero-fibrinous, or suppurative.

Acute serous synovitis of the knee is characterized by the presence of a turbid, serous fluid, with more or less numerous flakes of fibrin. In the sero-fibrinous form the amount of fibrin is more marked. The synovial membrane is swollen and hyperæmic. The clinical course of acute serous synovitis of the knee is briefly as follows: The joint is usually swollen, feels hot, and is painful when touched, and also spontaneously. In case there is an abundant exudation of serum, the patella floats, and there is distinct fluctuation. The knee joint can not be moved without pain, either actively or passively. There is usually little or no fever. The course of acute serous or sero-fibrinous synovitis is generally favourable, recovery following quickly in case of suitable treatment. Sometimes, however, it passes over into the chronic form or goes on to suppuration.

Acute suppurative inflammation of the knee joint either proceeds from the form of inflammation which has just been described or begins as such. Acute suppurative synovitis is characterized anatomically by the presence of a sometimes less and sometimes greater amount of pus in the joint, by marked swelling and hyperæmia of the synovial membrane and the ligaments, and by dulness of the articular cartilage with the formation of a vascular, delicate, newly formed connective tissue over the edges of the cartilage. The milder forms of acute suppurative synovitis of the knee, without deep destruction of the synovial membrane, are also called, after Volkmann, catarrhal suppuration of the joint. The longer the suppuration continues, or the more severe it is, the greater is the destruction of all parts of the joint. The pus breaks through the joint, periarticular abscesses are formed, etc. The worst cases are the acute septic inflammations of the knee joint, attended sometimes with the formation of gas.

The clinical course of acute suppurative synovitis of the knee is characterized by severe pain, high fever, which often begins suddenly with a chill, marked swelling, and pronounced functional disturbance. The joint is usually slightly flexed. The skin generally feels very hot and is reddened, and the entire extremity has more or less œdematous swelling. Fluctuation appears with the increasing accumulation of pus in the joint. The further course depends upon the nature of the infection, and also upon whether or not and how early antiseptic treatment is begun. The termination is either return to the normal, which is most likely to occur in catarrhal suppuration of the joint; or, most frequently, recovery with partial or complete ankylosis; or, finally, death. The latter usually results from pyæmia or septicæmia.

As regards the etiology of acute synovitis of the knee joint, the affection, when primary, most frequently arises from injuries of the joint. In other cases it is secondary to disease of the neighbouring tissue, especially the medulla or the periosteum, or metastatic in the course of pyæmia, typhoid fever, acute exanthemata, etc. The latter form is usually suppurative in character (see Principles of Surgery, page 661). For gonorrhœal arthritis the reader is referred to Principles of Surgery, § 113, page 662.

The diagnosis of acute synovitis of the knee is not difficult, in view of what has been said. Should the nature of the acute effusion in the joint be doubtful, an aseptic exploratory puncture may be made with an aspirating syringe.

The treatment of acute inflammation of the knee joint varies, of course, with the nature of the effusion, and follows general rules.

The treatment of acute serous and sero-fibrinous synovitis consists

at first in keeping the part at rest and giving it an elevated position with the use, it may be, of a splint and ice. After the inflammatory symptoms and the pain have subsided, the serous effusion in the joint is made to disappear by compression with a rubber bandage: massage is employed once or twice a day, and the patient is allowed to walk.

Aseptic puncture of the joint with a trocar, an aspirator, or a knife is indicated in case of very tense effusions, slow absorption, or chronic effusions.

In acute suppurative synovitis the pus should be evacuated by free incision and drainage of the joint, and resection may be indicated. After the operation the limb is placed upon a Volkmann splint, in an extended position, and immobilized by means of an antiseptic protective dressing. Periarticular collections of pus are likewise to be opened freely. In the worst cases of suppuration and sloughing of the knee joint amputation of the thigh will alone save the life of the patient.

For the treatment of other acute inflammations of the knee joint, acute articular rheumatism, gout, and gonorrhœal arthritis, see *Principles of Surgery*, page 665 ff.

Chronic Inflammations of the Knee Joint.—We shall first take up chronic serous synovitis. The symptoms are essentially the same as those attending acute serous synovitis, with the difference only that inflammatory manifestations are usually absent. The fluid that collects in the joint is either of thin or thick consistence, gelatinous, or colloid. After long continuance of the inflammation there usually result thickening of the synovial membrane, hypertrophy of the villi, and fibrillation of the cartilage. The formation of free bodies in the joint is frequent. Upon movement of the joint in such cases a corresponding creaking and grating are heard. The knee joint may finally become more or less loose, in consequence of the stretching of the capsule and the ligaments.

The best treatment of chronic synovitis of the knee consists in massage, active and passive exercise, and compression of the joint by means of a rubber bandage. If the purpose is not accomplished in this way, aseptic puncture of the joint is performed, with or without subsequent irrigation of the same with a three-per-cent solution of carbolic acid or 1-to-1,000 bichloride. The joint must be immobilized in an elevated position for some days after the operation by means of a splint and an antiseptic dressing that exerts pressure. Use is then made of massage and active and passive movements, and the patient is allowed to walk with an elastic knee-cap.

For diseases of the joints among bleeders (hæmophilia) see *Principles of Surgery*, page 686.

Among chronic suppurations of the knee joint, tuberculosis interests us most of all (tubercular arthritis of the knee, white swelling).

Tubercular Arthritis of the Knee (see also Principles of Surgery, page 672 ff.) sometimes develops primarily in the synovial membrane



FIG. 846.—Tubercular contracture and ankylosis of the knee in a boy six years of age. Cuneiform arthrotomy and union in an extended position.

and sometimes arises secondarily from a tubercular focus in the bone. I believe with König that the former is the more frequent method of development. As in other joints, so here also we distinguish three different forms of synovial tuberculosis, though they pass, to be sure, into one another: 1. The miliary form, without the formation of fungous granulations. 2. The most frequent—viz., the fungous form, with the formation of a granulation tissue permeated with tubercles, which fills the joint. 3. The fibrous form, with the formation of lardaceous thickenings of the synovial membrane. At the beginning of the disease the joint contains a serous or sero-fibrinous exudation, and later cheesy pus, varying in amount. In the further course the soft parts and the articular surfaces of the bones are more and more destroyed, and the normal tissue is replaced by the tubercular granulation tissue, as described more fully in Principles of Sur-

gery, page 673 ff. The destruction of the bone by tubercular caries may be very marked.

The course of tubercular arthritis of the knee is, as a rule, very chronic, often extending over years. It is most common among children, but adults of all ages are also attacked by it. The disease begins very gradually, though in rare cases its commencement is more acute. The initial symptoms are usually slight fatigue, an insignificant limping or dragging of the leg in walking, and pain after walking or standing for a long time. The first objective symptom is, then, a very gradually increasing swelling of the joint, either in the form of an effusion or of a more solid or fungous swelling. The skin is usually not reddened, but white and waxlike (hence the old designation "white swelling"). With the gradual enlargement of the joint the pain on

walking and standing also increases. The child has to remain lying down and the joint becomes more and more fixed. Contractures develop if they are not prevented by the early application of suitable splints (Fig. 846). In the further course, in the second stage, all the symptoms that have been thus far mentioned continue to increase in severity—that is, the swelling, the fixation, the pain, and the symptoms of suppuration of the joint become more and more distinct and are attended by more or less fever. The joint becomes disorganized, the caries progresses, periarticular abscesses are formed after the pus breaks through the capsule, and finally fistulæ develop.

Tubercular arthritis of the knee terminates either in healing or in death from general tubercular infection, from tuberculosis of the internal organs, especially the lungs and the intestines, from increasing marasmus, from amyloid degeneration, or from intercurrent diseases. Tuberculosis is the most frequent cause of death. The tubercular arthritis may heal at any stage either spontaneously or in consequence of the treatment, and it may last for years. Very striking shortening and general atrophy of the leg are commonly observed after such prolonged tubercular inflammations of the knee, even without operative interference. Lengthening of the leg (see page 829) is not so frequent. It never can be definitely stated when a knee joint that is tubercular is entirely healed, because the disease may suddenly break out anew and with great severity years even after an apparent cure, as, for example, the result of an injury. Generally speaking, the prognosis of every case of tuberculosis of a large joint, such as the knee, is unfavourable, and Billroth is right in stating that children who are operated upon for tubercular caries of a joint do not live to an old age; that only a minority of them, in fact, reaches early manhood and womanhood.

Treatment of Tubercular Arthritis of the Knee.—The treatment of tubercular arthritis of the knee is partly local and partly constitutional in character. The organism should be put in proper condition for meeting the struggle for life against the tubercle bacilli by a general strengthening treatment (good nourishment, good air, brine baths, sea baths, sea voyages, residence in a southern climate, in elevated health resorts, etc.).

The local treatment consists at first in giving the joint absolute rest—that is, the child must remain in bed, and any contractures are prevented by the use of plaster splints. The most important remedy is the early injection of ten-per-cent sterilized iodoform-glycerin or iodoform oil (from two to ten grammes every two to four weeks, according to the age of the patient). After the injection I give the knee joint light passive exercise, in order that the fluid may be distributed

throughout the joint. I have seen very surprising success attend these iodoform injections even in cases where fistulæ were present. (For the other methods of local treatment see Principles of Surgery, page 679.) As for the rest the treatment is symptomatic, as in tubercular inflammations of other joints. If pus is present in the joint, it is removed by opening the same, and the fungous masses or the tubercular synovial membrane are extirpated *in toto* with scissors, forceps, and a sharp spoon (so-called arthrectomy or synovectomy). In performing this synovectomy one can leave the bone entirely intact, if it is sound, and, at all events, as much of it is retained as possible. According to Angerer and Lingenfelder, about seventy-five per cent of the cases are cured by synovectomy. Typical resections should not be performed upon children if they can be avoided. Tubercular foci in the bone should, if possible, be opened with the chisel or a sharp spoon, packed with iodoform gauze, and allowed to heal by granulation. Amputation is permissible only when the preservation of life is in question, on account of too advanced destruction of the joint. In case of ankylosis, the joint should always be kept in an extended position, in order that it may be of use later in walking.

For the other inflammations of the knee joint the reader is referred to the following pages of Principles of Surgery: For chronic rheumatism, page 669 ff.; for syphilitic inflammation, page 682; for arthritis deformans, page 683; for nervous (hysterical) joint disease, page 690, § 116; for neuropathic affections of the bone and the joint, page 693, § 117. Sonnenburg and W. Müller have had very good results in chronic articular rheumatism from arthrotomy or synovectomy and irrigation of the joint. With reference to free joint bodies, the following should be stated as regards the knee joint (see particulars in Principles of Surgery, § 115, page 687 ff.): The knee joint is the favourite location of the different kinds of free bodies, especially in chronic hydrarthros and arthritis deformans of this joint. The diagnosis of a free body in the knee joint is usually easy, as it can generally be distinctly felt. In one case, however, I mistook a circumscribed tuberculosis of the capsule of the knee joint for a free movable body. The attacks of sharp pain caused by the body being caught between the articular surfaces are of great importance in making the diagnosis.

The treatment of free bodies in the joint, whose size varies from that of a bean or an almond to that of a hen's egg, consists in the removal of the same by an operation. The body is transfixed by some sharp instrument and cut down upon. After removing the body the edges of the wound are united by sutures. The knee joint is immobilized by means of an antiseptic protective dressing and a

splint. In case the body has a deeper location, and is not sufficiently accessible for a direct extraction, a free opening of the joint or its partial resection may be indicated. In all cases in which the patient refuses to submit to an operation an elastic knee-cap should be worn, which gives the joint some support and restricts its movements.

§ 339. **Contractures and Anchylosis of the Knee Joint.**—A large majority of the contractures and anchyloses of the knee are the result of inflammations of the joint. The anchylosis is either fibrous, cartilaginous, or bony. Contracture and anchylosis of the joint also ensue from shrinkage of the capsule and from pathological changes in the articular surfaces of the joint, with-



FIG. 847.—Contracture of the left knee in a position of acute-angled flexion.

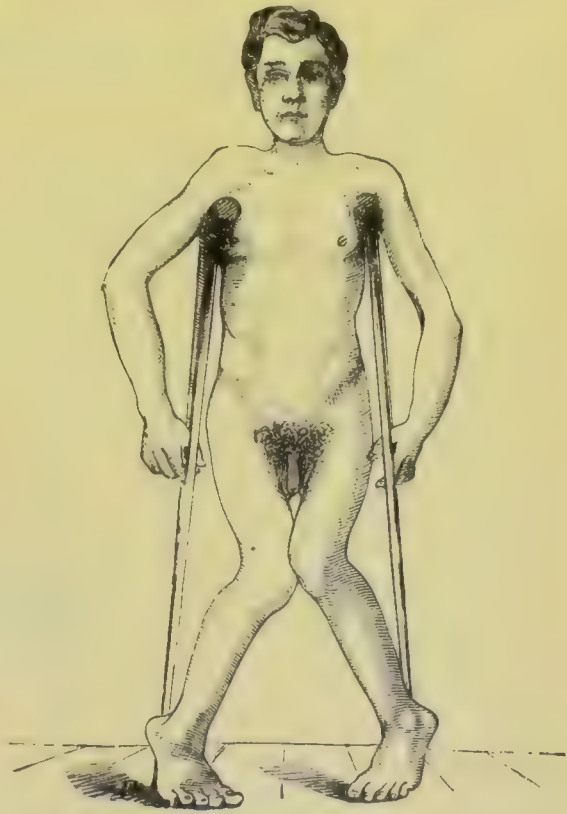


FIG. 848.—Spastic contracture of the lower extremity (Busch).

out any adhesion between the latter either by means of connective tissue, cartilage, or bone. These contractures may become very marked in consequence of unsuitable treatment of chronic inflammations of the knee joint, especially of the tubercular forms, as is seen, for example, in Fig. 847.

In other cases contractures of the knee are due to pathological changes in the soft parts about the knee joint. The most common causes of this form of contracture are cicatricial contractions of the skin and of the periarticular soft parts—e. g., after burns, after cicatrization of skin defects in the popliteal space, and, in general, after the cicatrization of traumatic or inflammatory defects of the skin and the other soft parts.

Myopathic and neuropathic contractures of the knee joint are the result of primary disease of the muscles and the nervous system. To the rare purely myopathic contractures belong, in the first place, the ischaemic contractures resulting from atrophy of the muscles of the thigh and the leg. They occur more commonly on the hand and forearm (see page 612). The much more frequent neuropathic contractures of the knee are divided into the spastic and the paralytic.

Spastic contractures of the knee, or, more correctly, of the lower extremity (Fig. 848), occur most commonly in the course of spastic spinal paralysis, which is characterized by muscular spasm and increased reflexes. They are caused by the most varied affections of the central nervous system.

The paralytic contractures of the knee joint result most commonly from injury and disease of the central nervous system and the peripheral nerves. They are more common, as we shall see, at the ankle. The paralytic contractures of the lower extremity arise partly from the action of the unparalyzed antagonistic muscles (Delpech), and partly in consequence of the weight of the limb and the load imposed by the weight of the body (Volkmann, Hueter). Infantile paral-

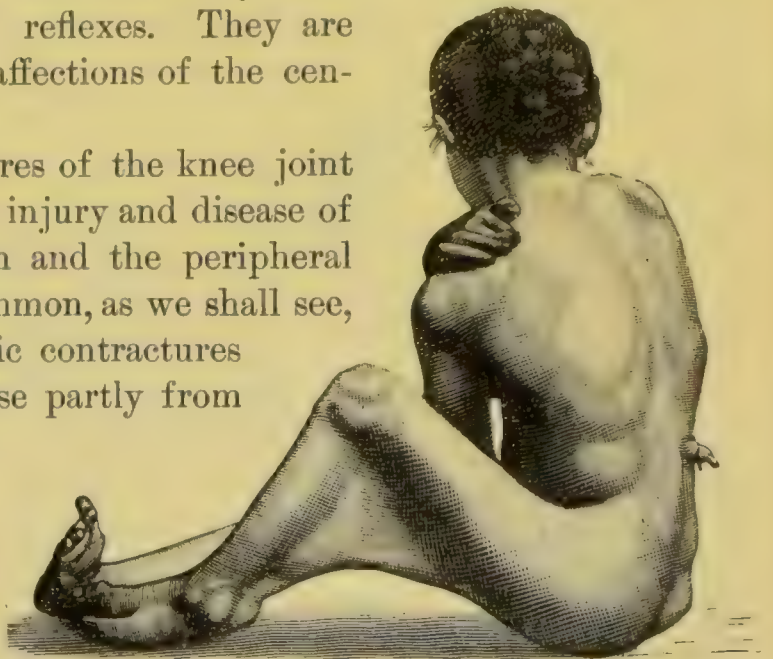


FIG. 849.—Congenital contracture of the knee due to web-formation in a girl nine years of age (Wolff).

ysis is a frequent cause of these paralytic contractures of the lower extremities. Contracture of the knee joint may also follow paralysis of the quadriceps muscle. A more detailed account of the paralytic contractures that result from disease of the central nervous organs will be found in works on neuropathology.

Congenital contractures of the knee joint are without special surgical interest. They occur most commonly among children who have other malformations. They include flexion contractures and extension contractures, the latter in an overextended position of the joint, also abduction contractures and adduction contractures of the leg (congenital genu valgum and varum) resulting from congenital shortening of the muscles or from malformation of the bony portions of the joint. The overextension contracture (genu recurvatum congenitum, Albert) has also been described as congenital dislocation of the leg (Maas, Porter, Dubrisay, Guéniot, Richardson, and others). Congenital contracture is sometimes combined with dislocation or absence of the patella.

A peculiar congenital contracture of the knee joint resulting from the formation of a sort of web was described by Julius Wolff (Fig. 849). The patella was absent. The girl had other malformations (syndactylism, clubfoot, absence of the toes). Basch and Fischer have described similar cases. Kredel observed a web between the chest and the left arm. Web formation is to be regarded as the expression of an incomplete differentiation of the extremities in consequence of disturbances of development *in utero*, owing, for example, to the absence of a sufficient amount of liquor amnii (Basch). In suitable cases the web should be divided and the knee extended as completely as possible.

The prognosis of all these contractures varies, of course, a great deal. It depends mainly upon their cause.

Treatment of Contractures and Anchylosis of the Knee.—Prophylaxis is of importance in all contractures—that is, care should be taken that in all diseases of the knee joint, and in all pathological changes in its vicinity, the joint be always kept in a suitable position—viz., in extension, in order that the development of a contracture may be prevented. If a contracture of the knee joint does develop after an acute or chronic inflammation of the joint has had its course, and if there is no bony anchylosis, the contracture is overcome either gradually by means of an extension apparatus, by a plaster splint, or by forcible extension under an anæsthetic. The front part of the plaster splint, corresponding to the knee joint, is cut out and the splint is simply divided in the popliteal space. By inserting pieces of cork posteriorly between the halves of the splint, one can extend the leg more and more. The two methods are usually combined—that is, the joint is extended as far as possible, with the patient under an anæsthetic, and it is then fixed in its improved position by means of an extension apparatus or a plaster splint. Forcible extension under an anæsthetic must always be executed with caution, lest a fracture, rupture of the soft parts, subluxation of the tibia, etc., occur. A recurrence of an apparently cured tuberculosis of the knee joint has been seen to follow this forcible extension. Gradual extension by means of extension apparatus should, of course, have the preference over forcible extension in all cases in which signs of inflammation of the knee joint still exist. In treating severe contractures that are of long standing, the joint should not be forcibly extended at a single sitting, but rather in several, and what is accomplished at each sitting should be retained by means of a plaster splint or an extension apparatus. The weights used with the latter may vary from four or five to ten kilogrammes, according to the age of the patient. The treatment of contractures by the use of portable apparatus or adjustable splints is also very successful. Tenotomy of the shortened flexors of the knee joint (biceps, semitendinosus, and

semimembranosus) is usually unnecessary, and should be performed only in case of extreme necessity.

As regards tenoplasty for lengthening shortened (retracted) tendons, after Sporon, see *Principles of Surgery*, page 467.

If there is a possibility of making the knee joint movable again after overcoming the contracture, massage, together with active and passive exercise, is especially to be recommended, upon the presumption, of course, that the disease in the knee joint has completely disappeared.

If the object is not accomplished by gradual extension by means of weights, by plaster-of-Paris splints, or by forcible extension, and if there is a firm, fibrous, cartilaginous or bony ankylosis, cuneiform resection of the joint or cuneiform osteotomy above the condyles of the femur is indicated. Judging from my own experience, cuneiform resection of the joint is to be preferred to supracondyloid osteotomy. A curved incision is made beneath the patella and a piece of bone sawn out or chiselled out from the tibia and the femur, corresponding to the angle of flexion of the ankylosed joint, and then, as in every resection of the knee, the bone surfaces are brought into apposition. A few tension sutures are inserted into the superficial wound and it is left partly open for the sake of drainage. After the hæmorrhage has been carefully arrested a plaster-of-Paris splint is applied over the antiseptic dressing, either immediately or after a few days, with the knee joint in a fully extended position.

To avoid the sacrifice of too much bone, E. Kummer and Helferich recommended sawing out a small semicircular wedge. The fascia and the tendons in the popliteal space are exposed by means of a longitudinal incision on the inner and outer side and divided. One may also, after König, Hahn, and others, make a linear division of the bone with a broad chisel through a curved incision below the patella and straighten the knee. The wound, which is either not closed at all or only by a few tension sutures, is covered with an aseptic protective dressing, and over this a plaster-of-Paris splint is immediately applied.

In performing supracondyloid osteotomy of the femur for angular bony ankylosis, a longitudinal incision is made above the joint on the posterior side of the femur and a suitable wedge-shaped piece of bone is chiselled out about nine centimetres above the edge of the condyles. In milder cases—that is, when the contracture is less pronounced—osteoclasis or simple linear osteotomy about nine centimetres above the edge of the condyles is sufficient. The wound is left open and packed with iodoform gauze, and a plaster-of-Paris splint is ap-

plied over the antiseptic dressing with the leg extended. Osteoclasis and osteotomy are, in my opinion, contraindicated in cases of extreme contracture with ankylosis, and when tubercular foci are still present in the bone.

Cicatricial contractures of the knee are overcome either by gradual extension by the use of weights, by interrupted plaster-of-Paris splints (which were mentioned on page 789), with pieces of cork inserted in the popliteal space between the two splints, or by means of an operation—e. g., by dividing the cicatrix and any other contracted soft parts, especially the fascia and tendons. Defects of considerable size are covered by skin-grafting or implanting a pedunculated skin-flap from the immediate neighbourhood or from a more remote part of the body—e. g., from the other extremity. In the latter case a pedunculated skin-flap of suitable width is marked out, dissected up and sutured into the defect with the least possible tension. The lower extremities are then laid across one another and fixed in this position by a plaster-of-Paris splint (Czerny). The flap is kept from drying by smearing it abundantly with vaseline, etc.

The treatment of paralytic and spastic contractions is directed, above all, against the underlying disease. The treatment of infantile paralysis consists in the employment of electricity, both galvanic and faradic, in massage, and in a general strengthening regimen. An effort is made by the use of suitable supporting apparatus or splints to prevent the development of deformities. A paralytic loose joint can be remedied by arthrodesis—i. e., the formation of an artificial ankylosis (see page 535). The spastic rigidity of the limb is treated by passive exercise, by protracted lukewarm baths, galvanization of the spinal cord, and irritation of the skin along the spine. In order to prevent or correct deformities, a suitable brace or plaster splint is employed. Tenotomy is also very useful, not only for its orthopædic value, but also for its antispasmodic effect. In case of flexion spasm of the knee joint, one may perform tenotomy of the biceps, the semimembranosus, the semitendinosus, and the gracilis muscles. In the case of a boy of seventeen years with congenital spastic paralysis, Lorenz operated upon ten tendons at one sitting, part of them by tenotomy and part of them by tendectomy—that is, excising a piece of the tendon one or two centimetres long. The contractures were thus overcome and the functional result was very satisfactory. In case of adduction spasms, neurectomy of the obturator nerve may also be performed (see page 723).

§ 340. **Other Deformities of the Knee Joint.**—Among other deformities of the knee, genu valgum and genu varum are especially important.

I. Genu Valgum (Knock-Knee).—By genu valgum (Fig. 850) is understood an abduction contracture of the leg, usually combined with hyperextension and outward rotation of the same. The line representing the direction in which the weight of the body acts and which normally passes from the top of the head of the femur through the knee and the ankle passes in genu valgum outside the knee.

Etiology of Genu Valgum.—Our knowledge regarding the etiology of genu valgum has been advanced of late, particularly by the careful studies of Mikulicz and Macewen. Genu valgum is a deformity due essentially to the weight of the body. Leaving out of consideration, to begin with, genu valgum resulting from malunion of a fracture of the lower end of the femur

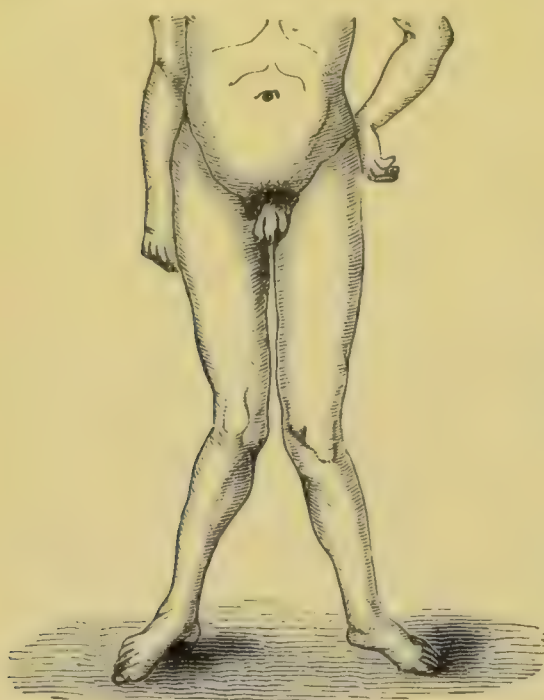


FIG. 850.—Genu valgum.

or of the upper end of the tibia, and also that resulting from dislocations of the knee joint, with loose joint, etc., we distinguish two principal forms of the affection—viz., the genu valgum of childhood and that at the age of puberty. The genu valgum of young children develops very early, when the children begin to walk and to stand. We have to do, without exception, with rhachitic children, whose soft bones bend from the weight of the body in walking and standing, especially at the lower portion of the shaft of the femur just above the epiphysis (rhachitic genu valgum). In some cases genu varum—that is, an adduction contracture of the leg—is developed in place of genu valgum. The deformity in genu valgum is due to the fact that the lower part of the shaft is curved inward in conse-

quence of rhachitis and the weight of the body upon the soft bones in walking and standing. The result of the bending of the femur is that the articular portion of the latter sits obliquely on the lower portion of the shaft. In the further course the length of the condyles of the femur becomes unequal. The external condyle is more burdened than the inner one in consequence of the outward displacement of the line in which the superimposed weight of the body acts. The internal condyle is therefore less hindered in its growth, and it becomes longer than the outer one. Similar changes also take place in the tibia. In advanced cases there is here the same bending of the bone in the epiphyseal region and inhibition of the growth of the external tuberosity. It can thus readily be understood that the line in which the weight of the body acts is displaced outward more and more, and that the abduction of the leg gradually increases. Other primary changes in the knee joint itself, according to Mikulicz and Macewen, do not exist. The underlying cause of genu valgum is always the primary extracapsular bending of the lower portion of the shaft of the femur particularly, but also of the tibia.

Only secondary changes occur in the knee joint, especially relaxation of the ligaments, fibrillation of the cartilage, displacement of the articular surfaces, etc.

Precisely the same changes are found, according to Mikulicz, in the second form of genu valgum, occurring at about the age of puberty. Those affected have either suffered earlier from rhachitis or still suffer from a late form of the same affection. It occurs mainly in persons whose occupation requires long-continued standing, such as bakers, waiters, blacksmiths, etc.

In addition to these two forms of genu valgum occurring in the earlier and later period of growth, the affection is also occasionally caused, as has been said, by the malunion of fractures of the lower end of the femur and the upper part of the tibia, by partial and complete dislocations of the knee joint, with relaxation of the ligaments (loose joint), etc. This form of genu valgum may occur at any time of life.

The symptomatology of genu valgum is evident from what has thus far been said. The principal symptom is the position of the knee joint at an angle which opens outward (Fig. 850), usually combined, in more advanced cases, with hyperextension and outward rotation of the knee joint. The deformity disappears when the knee is flexed, especially if the above-mentioned bending is confined to the shaft of the femur. This is true to a less extent, however, if the tibia is also oblique. This correction of the deformity by flexion is explained in part by a rotation of the leg in the opposite direction at the knee and the hip (Mikulicz), and in part by the greater antero-posterior diameter of the external condyle of the femur in comparison with that of the internal condyle (Girard).

In the further course of genu valgum secondary changes gradually develop at the hip and the ankle, to compensate for the abnormal position of the knee. The hip joint becomes more and more abducted and outwardly rotated to prevent the knees from striking against one another. In the early stages of genu valgum the foot has a pes-varus position, but later the inner border of the foot becomes more and more depressed—that is, pes valgus results, in consequence of a gradual weakening of the muscles and yielding of the arch of the foot. An oblique position of the pelvis and scoliosis of the spine gradually develop, especially in cases of marked unilateral genu valgum. The other leg is then curved outward, by way of compensation, giving rise to genu varum (Fig. 851).

The ability to walk in genu valgum varies a great deal and depends mainly upon the angle made by the femur and tibia, the looseness of the joint, the muscular power, and the more or less marked development of a pes valgus. The latter, if severe, may interfere very seriously with walking.

Treatment of Genu Valgum.—The treatment of genu valgum has improved with our increasing knowledge of its etiology and its nature. In treating children, orthopædic braces are sufficient, as a rule—e. g., an external splint with a joint which can be fixed at any angle of abduction up to full extension. The knee joint is drawn toward this splint by means of a knee-cap. The splint is attached to the shoe. In

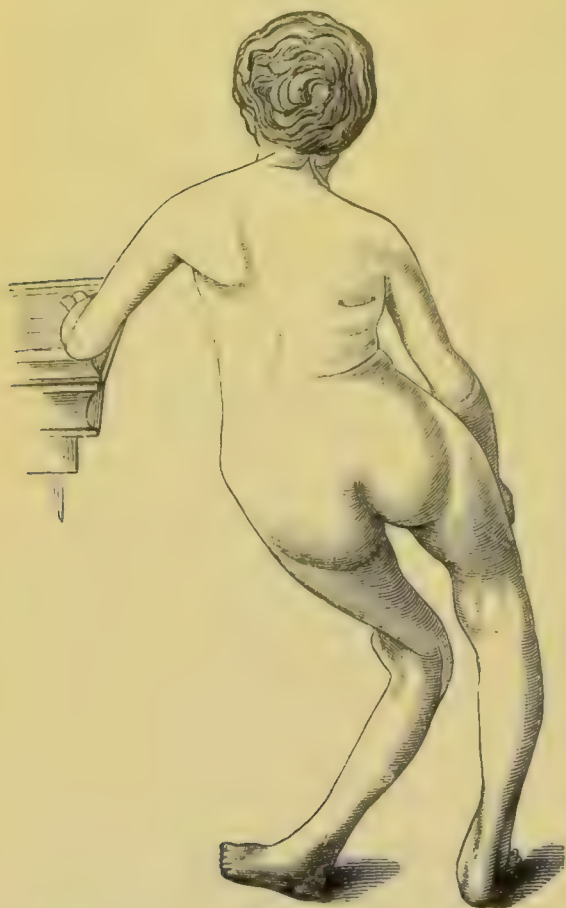


FIG. 851.—Extreme genu valgum of the left leg and genu varum of the right leg with marked tilting of the pelvis and scoliosis.

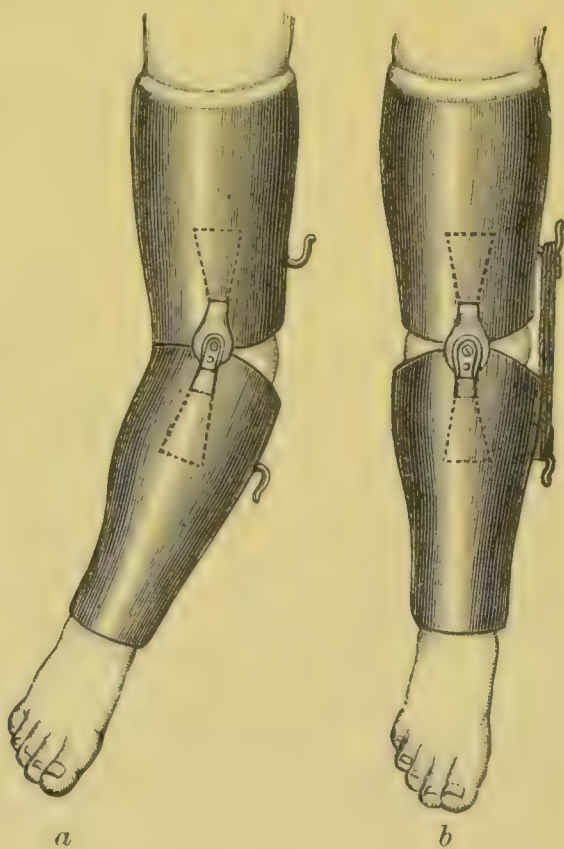


FIG. 852.—Mikulicz's plaster splint with elastic traction for the treatment of genu valgum.

the more severe cases of genu valgum among children a pelvic girdle is usually necessary. The existing rhachitis is to be treated according to general rules (see Principles of Surgery, page 643 ff).

Plaster-of-Paris splints are used a good deal—e. g., after the genu valgum has been corrected by forcibly breaking the lower end of the femur with the hands or an osteoclast. The leg can also be gradually straightened at a number of sittings without fracturing the bone, and a plaster-of-Paris splint then applied each time. Mikulicz has recommended plaster-of-Paris splints with elastic traction, as represented in Fig. 852. The leg having been enveloped in cotton, which is made especially thick on the inner side of the knee, a plaster-of-Paris splint is applied from the malleoli to the hip. After the splint has hardened, it is cut around in a circle, answering to the knee joint. The halves

of the splint are then united in front and behind by means of steel hinges, which allow only lateral movements, and are held by turns of the plaster bandages. A semilunar piece is now cut from each half of the plaster splint on the inner side of the knee, two hooks are secured by turns of the plaster bandages, one in the upper and one in the lower half of the splint, and the leg is straightened by means of rubber tubing wound about these (Fig. 852, *b*). J. Wolff's method is also a good one. A plaster splint is applied from the malleoli to the trochanter, with the patient under an anæsthetic, and before it hardens the leg is straightened as completely as possible by fixing the pelvis, forcing the inner condyle outward, and drawing the leg inward. After two or three days the leg is straightened still more by means of wedge-shaped excisions of the splint, much as in Mikulicz's method, and this process is repeated during the next few days. That the patient may also be able to bend his knee joint, a small iron splint with a hinge joint is fastened to the inside and the outside of the plaster splint by means of water-glass bandages. J. Wolff permanently cured even severe cases of genu valgum in this way in from twelve to thirteen weeks.

Treatment by means of an operation is indicated in all severe cases of genu valgum attended with marked functional disability, especially among adults. The most rational operation is the linear or cuneiform osteotomy of the femur above the internal condyle, after Macewen, which must be performed with strict observance of asepsis. The underlying cause of genu valgum, the bending of the femur above the epiphysis, is overcome by this operation. The bone is exposed by means of an incision through the skin and the vastus internus muscle, about two finger breadths above the upper border of the inner condyle of the femur. The femur is then chiselled through for about two thirds of its thickness, and the rest of the bone is broken. The wound remains open, is covered with iodoform gauze, and after the leg has been straightened a plaster splint is applied over the antiseptic dressing, which remains, it may be, from four to six weeks, until healing has taken place. The tibia also has to be chiselled through sometimes, either at the same sitting or later. If the tibia is the principal cause of the genu valgum, the osteotomy must be performed here.

Instead of osteotomy with a chisel, the femur may also be broken above the condyles by means of an osteoclast—e. g., that of Robin (osteoclasis).

Ogston's operation, which consists in sawing off the internal condyle obliquely within the joint and pushing the latter upward, so as to compensate for the difference in the length of the condyles, is altogether irrational and not unattended with danger. This operation has

properly been completely abandoned, and, if I am not mistaken, Ogston himself has given up his method and gives the preference to osteotomy by Macewen's method.

Ogston's method of operation is as follows: A narrow, pointed scalpel is inserted, with the knee joint sharply flexed, six or seven centimetres above the inner epicondyle of the femur, about in the middle of the inner surface of the bone, and then pushed obliquely downward and outward to the intercondyloid fossa of the femur. By now drawing the knife out backward, all the soft parts are divided to the bone, and the place of entrance made wide enough to allow a metacarpal saw to be introduced. By means of this the inner condyle is sawn nearly through from in front backward in the direction of the wound, and the rest of the bone is broken through by straightening the leg. The severed inner condyle is now pushed upward by the extension, which corrects the deformity. An antiseptic dressing and a plaster-of-Paris splint are then applied, and five to eight weeks are required for healing. The results were sometimes good, but there were many cases which were followed by bad sequelæ (suppuration of the joint, separation of the two condyles, disturbances of growth, arthritis deformans, etc.). One can easily convince himself upon the cadaver that this operation is a very severe one for the joint.

Reeves's modification of Ogston's operation—viz., the subcutaneous chiselling through of the inner condyle above its most prominent projection by carrying the chisel inward, forward, and finally backward—is also not to be recommended.

II. Genu Varum (Bowlegs).—Genu varum is the opposite of genu valgum—that is, an adduction contracture in which the concavity of the curvature is directed inward. We have to do here also with a rachitic curvature or angular bending of the lower part of the shaft of the femur and below the epiphysis of the tibia, which occurs particularly among rachitic children and less often at the age of puberty (see also page 828).

The treatment consists, in addition to curing the rickets, in the use, in milder cases, of splint apparatus. In severe cases the curvature is corrected either by aseptic osteotomy or by subcutaneous fracture, either with the hand or by the use of an osteoclast—e. g., that of Lorenz. Linear osteotomy is usually sufficient. Cuneiform osteotomy is but seldom necessary. Here also a sufficiently long skin incision is made and the bone chiselled most of the way through and the rest broken. If necessary, the fibula is also broken subcutaneously with the hands. The wound remains open, is covered with iodoform gauze and an antiseptic dressing, and over this a plaster-of-Paris splint is applied, which remains from four to six weeks, until healing is complete (see also page 828).

§ 341. **Diseases of the Bursæ in the Vicinity of the Knee Joint.**—The number of bursæ about the knee joint is very variable. Gruber has

described, for example, eighteen different bursæ. They often originate secondarily, as is well known, in all those parts of the body where the soft parts lying over the bone are exposed to frequent pressure and to displacement. Inflammations of the most important and the constant bursæ about the knee joint are of great surgical importance, particularly those of the bursa præpatellaris, also of the bursa infragenualis beneath the ligamentum patellæ, the bursæ epicondylicæ, the bursa semimembranosa, and the bursa poplitea.

I. Inflammations of the Prepatellar Bursa.—This bursa lies upon the anterior surface of the patella and never communicates with the knee joint. It often consists of three cavities, lying one above another, and standing in open communication, so that a subcutaneous, a subfascial, and a subtendinous bursa may be distinguished (Linhart). The prepatellar bursa is frequently the seat of acute and chronic inflammation.

The acute inflammation of the prepatellar bursa (acute prepatellar bursitis) is either serous, sero-fibrinous, or suppurative. A characteristic circumscribed, fluctuating swelling is formed upon the anterior surface of the patella in consequence of the accumulation of secretion. The suppurative inflammation sometimes assumes a phlegmonous character, and may break through into the neighbouring cellular tissue.

Chronic prepatellar bursitis (prepatellar hygroma) is characterized by a painless circumscribed, fluctuating tumour upon the anterior surface of the patella under a covering of normal skin. The contents of the hygroma consist of a (for the most part) mucous fluid, either of thick consistence or more serous. After the hygroma has existed for some time, the walls of the bursa are thickened, often calcified, and covered with villous, vascular proliferations. In such hygromata of long standing free bodies are frequently found which are called corpora oryzoidea. They are, according to the investigations of H. Meckel, Volkmann, and others, in part amorphous fibrin concretions, resembling rice grains or melon seeds, resulting from deposits of fibrin from the thickened contents of the hygroma, while others result from the detachment of fibrillary or cartilaginous proliferations from the wall of the bursa, which are enlarged by infiltration and apposition of albumin and fibrin from the contents of the hygroma. In the latter case the bodies have a fibrillary or cartilaginous nucleus. The number of such bodies in old hygromata may be very marked, so that the hygroma feels like a bag filled with shot. A hygroma of the prepatellar bursa may, in rare cases, develop into a tumour—e. g., a myxoma (see page 801, Fig. 855).

The prepatellar bursa frequently contains blood (prepatellar hæma-

toma). These hæmatomata occur sometimes in consequence of contusion of a normal or already diseased bursa, and we have then to do with pure traumatic effusions of blood into the bursa. In other cases the hæmatomata are the result of a chronic bursitis, which is characterized by the formation of a villous, vascular granulation tissue, much as in a hæmatocele of the tunica vaginalis of the testicle.

Prepatellar hygromata arise most commonly from mechanical causes, particularly among those individuals who constantly expose the anterior surface of the knee to pressure and irritation, especially servant girls, who move about a great deal on their knees—e. g., in cleaning floors—also shoemakers, etc. The inflammation is sometimes syphilitic or tubercular. Every hygroma may be complicated by subacute and acute exacerbations and suppuration—e. g., in consequence of a wound of the skin or of the bursa, from a furuncle, and also in connection with syphilis and tuberculosis.

The treatment of acute prepatellar bursitis conforms to general rules. In treating milder serous or bloody effusions, the application of iodine with a brush, compression by means of a rubber bandage or an elastic knee-cap, and massage, are often sufficient. In case of acute suppurative bursitis or a large collection of serum or blood (hæmatoma), the bursa is opened, under local anæsthesia, in the middle line by means of a longitudinal incision. The cavity is irrigated with 1-to-1,000 bichloride, and the wound left partially open and drained at its upper angle and the leg elevated. An antiseptic protective dressing is applied.

Chronic hygromata and hæmatomata are likewise treated by opening the sac in a longitudinal direction under local anæsthesia. The thickened, calcified, and otherwise degenerated inner wall of the sac is excised as far as possible. A more rapid cure is effected in this way than by puncture and injection of tincture of iodine, which was formerly the usual procedure. In tubercular and syphilitic bursitis likewise the diseased bursal sac should be as thoroughly excised as possible.

II. Inflammations of the other Bursæ about the Knee Joint.—Precisely the same acute and chronic inflammations occur in the other bursæ as in the prepatellar bursa.

1. *Inflammations of the Bursa Infragenualis and the Bursa Subcutanea over the Tubercle of the Tibia.*—The bursa infragenualis lies beneath the ligamentum patellæ, just above the tubercle of the tibia. It does not communicate with the knee joint. Hygromata of this bursa are rather common. They have been described in detail by Trendelenburg. A subcutaneous bursa is often found upon the tubercle of the tibia, which likewise becomes inflamed, especially among those who work on their knees.

2. *Inflammations of the Bursæ Epicondylæ.*—Hueter, in particular, has called attention to these inflammations. The bursæ lie in the fascia covering the two epicondyles of the femur, where the lateral ligaments have their insertion. Hæmatomata and chronic inflammation and suppuration of these bursæ have been observed, and the knowledge of their position is, therefore, of importance, lest one should mistake inflammatory processes within them for diseases of the knee joint or of the femur.

3. *Inflammations of the Bursa Poplitea.*—The bursa beneath the popliteus muscle is to be regarded as an extension of the synovial membrane of the knee joint, with which it always freely communicates. In case of inflammatory processes the communicating opening may be closed. The hygromata of the popliteal bursa, especially in the latter case, form corresponding circumscribed swellings at the outer portion of the popliteal space, which can be felt, especially when the knee joint is flexed. If the communicating opening is not closed, the tumour becomes smaller when the joint is extended, because it then discharges part of its contents into the joint. In the hygromata of this bursa we have to do essentially with a chronic synovitis of the knee joint, and the contents can be pressed from the anterior into the posterior portion of the joint, and *vice versa*.

4. *Inflammation of the Bursa Semimembranosa.*—The semimembranosus bursa between the muscle of the same name and the inner head of the gastrocnemius but rarely communicates with the knee joint. The communicating opening is sometimes very small. The same forms of inflammation are occasionally observed here also that we have described above in connection with the prepatellar bursa. If a hygroma of this bursa can be made smaller by pressure, it is very probable that the latter communicates with the knee joint.

The treatment of the inflammations of all these bursæ mucosæ is the same as that given above for the diseases of the prepatellar bursa. In dealing with all hygromata that communicate with the knee joint—that is, those particularly of the popliteal bursa and, it may be, the semimembranosus bursa—the strictest aseptic methods must be employed in case an operation is indicated, which is rarely the case, however, as the discomfort attending simple hygromata of these bursæ is very slight. If a hygroma in the region of the knee joint can be emptied by pressure, it is an indication that it communicates with the joint. Instead of making an incision, in such cases, one could perform aseptic puncture with subsequent compression.

§ 342. **Tumours in the Region of the Knee Joint.**—Among the tumours in the region of the knee, sarcomata of the lower end of the femur and of the upper end of the tibia, which occur here more frequently than anywhere else on the extremities, are especially important. We have already spoken of sarcomata of the lower end of the femur on page 740. These sarcomata are observed most frequently in adults, but they are not infrequent among young persons also under twenty years of age—that is, before the growth of bone is at an end; and it is therefore very probable that the tumour formation frequently begins before completion of the growth of bone at the epiphysis. The

sarcomata originate most frequently in the medulla (myelogenic sarcomata). They are less often periosteal in their origin. At the outset the enlargement of the bone may be mistaken for tuberculosis of the lower end of the femur or the upper portion of the tibia. The myelogenic sarcomata finally break through the bony covering, so that the

diagnosis is then no longer in doubt. As a rule, the tumour does not break through the articular cartilage into the knee joint. These sarcomata sometimes grow to the size of a man's head. As at other epiphyses—e. g., that of the humerus—so here also very vascular pulsating sarcomata occur. A cysto-sarcoma of the femur is represented on page 740.

The treatment of the sarcomata at the lower end of the femur and the upper end of the tibia consists in prompt amputation of the femur at the middle of the thigh or still higher. Recurrences occur in the stump of the femur and in the pelvic bones in most cases, and the patient dies comparatively soon from metastasis. Amputation at

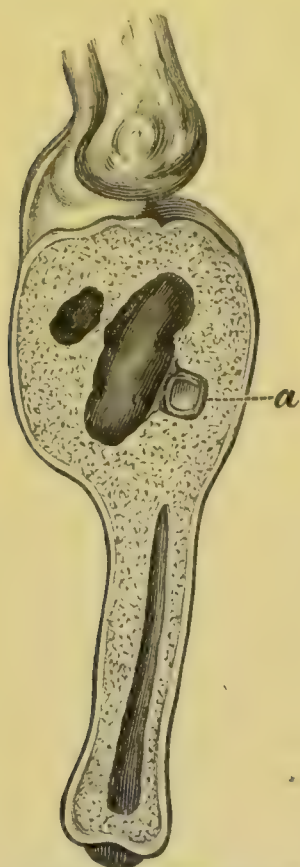


FIG. 853.—Abscess in the head of the tibia of sixteen years' duration: *a*, cloaca with external opening which was kept closed by a stopper. The latter was removed by the patient several times a day in order to evacuate the pus. Amputation of the thigh (Stanley).



FIG. 854.—Echinococcus cyst of the femur and tibia in a woman fifty-two years of age: *a*, large echinococcus vesicle. Amputation of the thigh (Hahn).

the hip does not usually prevent death from metastasis if the tumour is of long standing.

Bone abscesses in the upper part of the tibia and the lower part of the femur may resemble tumours very closely (Fig. 853). Such chronic bone abscesses are usually of tubercular origin, or they may be caused by acute or chronic osteomyelitis or syphilis. They are most quickly healed by chiselling open the lower end of the femur or the upper end of the tibia.

The enlargement of the lower end of the femur and the upper end of the tibia can be conditioned, in other cases, upon echinococcus (Fig.

854). Echinococcus bone cysts are slowly growing, indolent tumours, which are sometimes painful in their later stages, and which present at first the appearance of a tumour originating in the bone. Later on the cysts break through the cortex into the surrounding soft parts and into the joint, and are then easy to diagnosticate. The treatment consists either in chiselling open the bone and thoroughly scraping it out, or, it may be, in amputation or disarticulation of the knee.

For a description of exostoses, whose favourite place is the lower end of the femur, the reader is referred to page 740. We have there also spoken of the exostosis bursata and the intra-articular exostoses of the knee joint. The osteomata and exostoses at the epiphyses of the femur and the tibia may occasion arrest of growth. They sometimes occur in multiple form on several epiphyses. I have twice removed for officers of hussars exostoses below the point of insertion of the ligamentum patellæ. They were exactly at the place where the button at the upper edge of the leg of the boot had exercised a constant pressure. They occasioned severe pain.

Among tumours of the soft parts, the fibromata and sarcomata are especially to be mentioned which originate in the fascia, the vessel sheaths, and the lymphatic glands. The cysts in the vicinity of the knee joint are mostly hygromata of the bursæ, which we have described above on pages 798 and 799. Poisier distinguishes, with reference to their origin, four kinds of these so-called cysts in the popliteal space: (1) The most frequent are those which originate in the bursa between the semimembranosus and the semitendinosus; (2) others develop from a synovial extension of the popliteal bursa and often possess a very long pedicle leading toward the joint; (3) cysts in the upper part of the popliteal space, near a condyle, arise from small synovial pouches between the fibres of origin of the gastrocnemius muscle; (4) subsynovial follicular cysts, also designated as synovial herniæ. In rare cases hygromata give rise to the development of genuine tumours, as, for example, in Fig. 855.

For aneurisms of the popliteal artery the reader is referred to page 780.

Of tumours in the knee joint itself there occur, aside from the

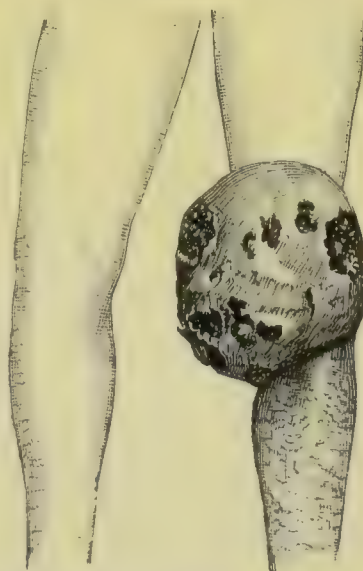


FIG. 855.—Myxoma of the præpatellar region which developed from a hygroma of the præpatellar bursa in a farmer sixty-two years of age. Extirpation, followed by death from hypostatic pneumonia fourteen days after the operation (Ranke).

intra-articular exostoses, which have already been mentioned, lipomata, originating in the adipose ligamenta alaria; also gummata of the capsule and sarcomata of the synovial membrane. Lipomata of the knee joint have been successfully removed by aseptic incision by König, Lauenstein, Volkmann, and Wagner. Sarcomata of the synovial membrane necessitate amputation of the thigh. As regards loose bodies in the knee joint, see page 786.

§ 343. **Resection of the Knee.**—The typical resection of the knee joint with removal of the articular ends of the femur and tibia has been supplanted to some extent of late by simple arthrectomy—that is, by extirpation of the diseased synovial membrane (synovectomy), with the preservation of the bone so far as possible. König was the first, no doubt, to emphasize the utmost possible preservation of the bone and to recommend simple arthrectomy. In place of the name arthrectomy I have adopted, with Ollier, the more correct designation synovectomy. Many surgeons, however, remain zealous champions of resection and never employ synovectomy. Extensive resections of the articular surfaces are particularly to be avoided among children, on account of injury to the epiphyseal cartilage and the disturbance of growth conditioned thereupon. Synovectomy is here, in suitable cases, strongly to be recommended. The chief advantage of synovectomy is the fact that no shortening occurs and that a movable joint is possible afterward. Foci in the bone are, to be sure, not infrequently overlooked, so that resection becomes necessary later on account of recurrence. Another disadvantage of synovectomy is, that the tendency to flexion contracture is greater than after resection. Mandry tabulated seventy cases of synovectomy of the knee joint among children. There were seven deaths, forty-four complete cures, and nineteen recurrences. In no case did shortening occur; there was lengthening of the leg in three cases, ankylosis ensued in thirty-two cases, a movable joint in eight cases, and a loose joint in no case. There was flexion contracture in fifty-five per cent of these cases. Lingenfelder reported seventy cases of synovectomy of the knee joint in Angerer's clinic. Favourable results were secured here also. Primary union ensued in forty-eight cases. Seventy-five per cent of the patients were cured and seven (ten per cent) died. Ankylosis in a position of extension or slight flexion was usually aimed at. Nearly complete normal movement was secured in one case.

Bothe reported upon the final results of one hundred and thirty-two resections of the knee joint in Bruns's clinic. It was found that the tubercular process began usually in the bone. Complete and permanent cures were secured in eighty-seven per cent of the cases. There

were one hundred and five synostoses. Union took place in an angular position in fifty-five per cent, and in a position of complete extension in forty-five per cent of the cases. Disturbances of growth were frequent, and were compensated for to the extent of seven centimetres by lowering the pelvis.

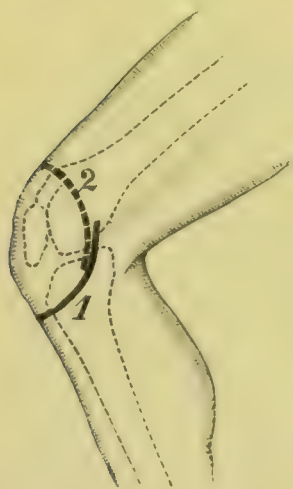


FIG. 856.—Resection or arthrectomy of the knee: 1, Textor's lower curved incision; 2, Hahn's upper curved incision.

Lengthening of the leg was observed in four cases. Life was not at all endangered by the operation as such. Hitze-grad collected one hundred and fifteen cases of resection of the knee joint in Esmarch's clinic. Eighty-nine of these patients were under twenty years of age. Seventy-three per cent were completely cured, the average time required being eighty-five days. Of those who were discharged cured or partially so, ninety-one per cent were in the enjoyment of a good use of the

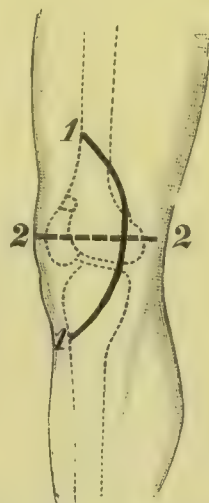


FIG. 857.—Resection or arthrectomy of the knee: 1, Langenbeck's internal curved incision; 2, Volkmann's transverse incision over the middle of the patella.

leg after the lapse of five and a half years, upon the average. C. Neugebauer (clinic at Strasburg) reached approximately the same results, based upon one hundred and one resections of the knee joint. Schlüter made a comparison, based upon a large number of cases from the Göttingen clinic and from the literature of the subject, of the results and prognosis of resection of the knee for tuberculosis in young and older subjects, and reached almost the same figures in both cases.

In all diseases of the knee the joint is to be opened by a straight or curved transverse incision. Only in this way can the joint be sufficiently exposed. The less injurious longitudinal incision is not suited for the purpose, as it does not permit a complete excision of the diseased synovial membrane. Bony ankylosis is to be striven for after every resection of the knee. Three different transverse incisions are at our disposal: 1. The lower curved incision, after Textor, beneath the patella and through the ligamentum patellæ (Fig. 856, 1). 2. The upper curved incision along the upper border of the patella, after Hahn (Fig. 856, 2). 3. The transverse incision over the middle of the patella, after Volkmann (Fig. 857, 2).

1. Resection or Arthrectomy (Synovectomy) of the Knee Joint by Means of the Lower Curved Incision through the Ligamentum Patellæ (Fig. 856, 1).—The curved incision runs, with the knee flexed at right

angles, from the posterior border of one epicondyle of the femur through the ligamentum patellæ, just above the tubercle of the tibia, to the epicondyle of the femur on the other side. The skin, the ligamentum patellæ, and the capsule are divided at one stroke. As the knee is flexed more and more, both lateral ligaments and the crucial ligaments are divided. The joint now lies open to such an extent that the capsule can be extirpated *in toto* with forceps and scissors. The upper prolongation of the capsule in particular and the posterior part of the same in the popliteal space must be carefully excised. Care should be taken in the popliteal space not to wound the popliteal artery. The latter is most easily wounded behind the external tuberosity of the tibia, where it is less than one centimetre distant from the capsule. If the bone is healthy, extirpation of the synovial membrane is sufficient. Otherwise, the parts of the bone that are affected are scraped out and as much as possible of the bone is retained. Great care should be taken in children not to injure the epiphyseal cartilage. The patella is usually removed, even when it is sound. The typical removal with the saw of the ends of the femur and the tibia should be resorted to only in case of extreme necessity. In the latter case the resected bone surfaces are united by suture (see Principles of Surgery, page 110), or by the use of long aseptic steel nails. One nail is driven obliquely through the femur into the tibia and the other through the tibia into the femur. They remain until the end of the third or the beginning of the fourth week, and they are then usually so loose that they can easily be drawn out with the fingers. In the fixation of the bones care must be taken that the posterior edge, particularly of the tibia, does not project too far in the direction of the popliteal space and press upon the vessels. Erosion of the popliteal artery and gangrene of the leg may result from such pressure (Braun, P. Vogt). Instead of sawing off the ends of the bone transversely, one may saw them so as to form steps which fit together, or the femur in the shape of a wedge and the tibia correspondingly in the form of a groove, or finally the femur may be rounded off and the tibia hollowed out. The hæmorrhage is arrested, the ligamentum patellæ sutured with catgut, the outer wound partially sutured, and three drainage-tubes introduced (one into the upper recess and one into each of the two angles of the wound and directed toward the popliteal space). An antiseptic dressing is applied and the limb is placed upon a Volkmann splint. Of late I have done away with drainage. I suture the wound only partially, and either immediately or after two or three days apply a plaster-of-Paris splint over the antiseptic dressing.

2. The upper curved incision, after Hahn (Fig. 856, 2) is a very

excellent one. It permits a good exposure of the diseased joint, and the upper recess of the knee joint, in particular, is thoroughly opened. The incision runs from one tuberosity of the tibia in a curve through the tendon of the quadriceps muscle, near the upper border of the patella, to the other tuberosity of the tibia. After the joint has been opened the flap of soft parts is reflected downward. The further course of the operation is the same as described above.

Volkman recommended a transverse incision across the middle of the patella (Fig. 857, 2). The knee joint is slightly flexed and rests upon a block of wood or a roller cushion. The incision is begun upon one side, answering to the line of the joint, and carried transversely over the middle of the patella to a corresponding point on the other side. The patella is sawn through transversely with a metacarpal saw and removed, it may be, or preserved and then sutured together again after the completion of the operation. Ollier usually employs the H-shaped incision, after Moreau—that is, makes a transverse incision below the patella and a longitudinal incision on each side to the inner side of the lateral ligaments, which are to be preserved.

Tiling preserves the extension apparatus of the knee joint as far as possible so as to secure a more movable joint after synovectomy. He makes two parallel lateral incisions which begin one or two finger breadths above the epicondyles and extend to a point below the level of the tubercle of the tibia. The lower ends of the lateral longitudinal incisions are united by a transverse incision below the tubercle. The joint is opened laterally in the course of the longitudinal incisions on the inner side of the lateral ligaments. The anterior border of the tibia is sawn off obliquely with a metacarpal saw from in front and below, upward and backward, or chiselled off. The insertion of the ligamentum patellæ is thus kept intact. The flap of soft parts and bone is reflected upward. The inner and outer epicondyle of the femur are then chiselled off to the thickness of one or one and a half centimetres with a broad chisel and the insertion of the lateral ligaments thus preserved. Division of the crucial ligaments now follows, and the further course of the operation is as above. If the bone is sound, excision of the synovial membrane is all that is required. The epicondyles of the femur and the anterior border of the tibia are then fixed again in their normal place by means of ivory pins.

The subperiosteal resection of the knee by means of a lateral curved incision, after Langenbeck, is adapted only for traumatic cases, especially gunshot fractures. The skin incision on the inner side of the extended knee joint (see Fig. 857, 1), which is from fifteen to twenty centimetres long, begins five or six centimetres above the patella at the inner border of the rectus femoris muscle, runs downward in a curve with its concavity directed forward, and ends five or six centimetres below the patella. The tendon of the sartorius muscle in the lower angle of the wound and the vastus internus muscle, with the tendon of the adductor magnus lying beneath it in the upper angle, must not be injured. After the skin incision has been deepened to the bone or into the joint the knee is flexed, and, while it is slowly extended again, the patella is dislocated by pressure. The patella can be made

more movable and its dislocation facilitated by slightly snipping the ligamentum patellæ. Then follow division of the crucial ligaments and of the external lateral ligament, together with the neighbouring parts of the capsule and its posterior wall. The articular surfaces of the femur and the tibia are forced out through the wound one after the other, with the knee joint flexed and sawn off. If the patella is sound it is preserved. Then follow drainage (one drainage-tube is introduced into the wound, a second through a counter-opening on the outer side in the direction of the popliteal space, and a third into the upper recess), suture, the application of a dressing, and a Volkmann splint. If the wound runs an aseptic course, a plaster-of-Paris splint is applied over the antiseptic protective dressing after the removal of the drainage-tubes.

After every resection or synovectomy, flexion contracture is to be avoided as far as possible. Resection for contracture and ankylosis of the knee is described on page 790.

A paralytic loose knee joint may be placed in a condition of artificial ankylosis by the operation of arthrodesis (page 535).

§ 344. **Disarticulation of the Leg at the Knee Joint** is performed either by the circular or the flap method.

In disarticulation of the knee by the circular method the skin is divided by a circular incision about eight centimetres below the patella

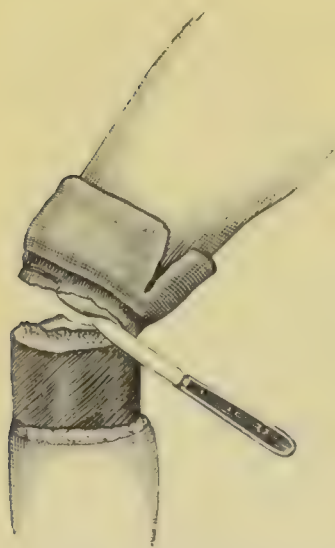


FIG. 858.—Disarticulation of the knee. Circular incision with lateral division of the cutaneous cuff.

with the knee joint extended. The skin is dissected up on all sides as far as the lower border of the patella and reflected in the form of a cuff. To facilitate this reflection, lateral incisions may be made in the cuff either on one or on both sides (Fig. 858). The remaining soft parts are now simply divided by a circular incision in the line of the joint, but it is better, however, to disarticulate from in front as follows: The knee joint is flexed, the ligamentum patellæ divided just below the patella, and the capsule and the lateral ligaments are severed close to the lower border of the femur so that the semilunar cartilages may remain attached to the tibia (see Fig. 858). The crucial ligaments are divided as the knee joint is flexed more and more, and the leg is then extended and the soft

parts divided in the popliteal space likewise from in front backward. The wound is finally drained, especially through the posterior flap, and sutured, preferably in a transverse direction. If the patella and the upper prolongation of the capsule are to be removed on account of disease, this is most easily accomplished through a longitudinal incision over the middle of the patella.

Disarticulation by the use of flaps is performed as follows (Fig. 859): A semicircular posterior skin-flap about eight centimetres long is made in the popliteal space with the leg elevated, the incision extending from the lateral border of one condyle of the femur to that of the other. The knee is then flexed and a longer anterior flap, ten to twelve centimetres in length, is marked out and dissected up as far as the lower edge of the patella. The anterior cutaneous flap is reflected upward, and the disarticulation is then completed as in the circular method. Here also it is easy to remove the patella.

Another good plan is to cut a long, well-nourished U-shaped posterior flap consisting of skin and muscle which extends down below the middle of the calf, and to make in front a slightly curved incision which divides the ligamentum patellæ and opens the joint (Blandin, Ritschl). Out of eighty-five cases of disarticulation at the knee, twelve died, most of them not as a direct result of the operation, which is a mortality of 14·3 per cent (Ritschl).

The vessels which need to be ligated in disarticulation at the knee are the popliteal artery and vein or their terminal branches, the posterior and anterior tibial arteries, the muscular branches to the two heads of the gastrocnemius muscle, and the branches forming the circum-patellar anastomosis.

In place of disarticulation at the knee joint, Gritti's amputation and the trancondyloid amputation after Carden and Lücke may be employed. The latter consists in sawing off the articular portion of the femur through the condyles or above them after disarticulation at the knee has been performed. The sharp edges of the sawn surface must be smoothed off with the saw, chisel, or bone-cutting forceps. Bergmann recommends sawing off the bone, not horizontally, but in a rounded form, without sharp edges, corresponding to the lower surface of the condyles of the femur. The supracondyloid or trancondyloid amputation of the femur has the advantages over disarticulation at the knee that the wound surface is smaller, that the time required for healing is shorter, and especially that one does not require such a long flap as in disarticulation at the knee, which, owing to the fact that the cartilaginous surface of the femur is destitute of vessels, may suffer necrosis.

Gritti's operation is similar to Pirogoff's amputation of the foot. As in the latter the posterior portion of the os calcis is attached to the

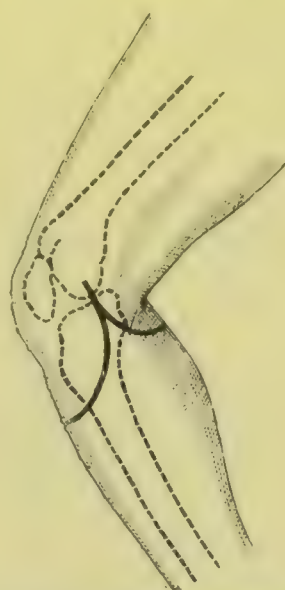


FIG. 859.—Disarticulation of the knee by means of a flap incision.

stump of the tibia, so here the freshened patella is united to the stump of the femur. After disarticulation at the knee has been performed as described above, the cartilaginous surfaces of the femur and of the patella are sawn off and the two sawn surfaces are brought into apposition. The patella may, if desirable, be fastened to the stump of the femur by the use of catgut or a nail, but this is usually unnecessary. The principal thing is that the patella shall lie upon the end of the femur without tension.

Very different views are taken as to the relative advantages of the operations that have just been described and as to the comparative usefulness of the various stumps. This much is certain, that, generally speaking, simpler wounds are made by the transcondyloid or supracondyloid amputation of the femur, and that neither disarticulation at the knee nor Gritti's operation should be performed upon old people with a thin cutaneous covering and osteoporosis. On the other hand, there is no doubt that the stump is much more serviceable after disarticulation at the knee than the best amputation stump. It is to be looked upon as an advantage of Gritti's operation, when successfully performed, that the femur and the patella do not atrophy after they have united and do not become pointed, so that here also a permanently good stump results.

For the osteoplastic intercondyloid amputation of the femur, after Sabanejeff, see page 752.

§ 345. **Injuries of the Soft Parts of the Leg.**—The muscles and tendons are occasionally ruptured subcutaneously, particularly the muscles of the calf, the tendons of the peronei, and the tendo Achillis. Smaller rents in the muscles of the calf may arise from jumping and spontaneously from a cramp. These rents in the muscles are characterized by circumscribed extravasations of blood. Hueter is probably right in his belief that cramps in the muscles of the calf are frequently caused by varicose veins within the muscles. The pain attending cramps of the calf muscles is largely due to compression of the communicans poplitei nerve between the two heads of the gastrocnemius muscle. Ruptures of the plantaris muscle with its long tendon, which lies between the soleus and the gastrocnemius muscles, are of no surgical interest.

Of greater importance is the rupture of the tendo Achillis and the dislocation of the peroneal tendons which lie behind the external malleolus. The transverse rupture of the tendo Achillis above the os calcis or at its point of attachment, with or without avulsion of bone from the os calcis, sometimes occurs in consequence of powerful contraction of the calf muscles. In other cases the tendon remains intact, and a transverse fracture of the body of the os calcis near its posterior surface may result.

The treatment of transverse rupture of the tendo Achillis consists in exposing the two ends of the tendon and suturing them with catgut or silkworm gut. To relax the muscles of the calf as much as possible, the dressing is applied with the foot in a position of plantar flexion and with flexed knee. If a piece of the os calcis is torn off it should be brought back into its normal position and a plaster-of-Paris dressing applied, with the foot in plantar flexion and with bent knee. Suture or aseptic nailing will be resorted to, if necessary, with or without tenotomy of the tendo Achillis.

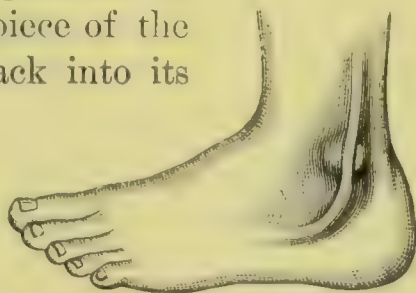


FIG. 860.—Dislocation of the tendon of the peroneus longus upon the outer side of the external malleolus.

Dislocation of the peroneal tendons upon the outer surface of the external malleolus after rupture of the tendon sheaths (Fig.

860) is very rare, and dislocation of the tendon of the tibialis posticus upon the internal malleolus is still more so. Sometimes a prompt cure is effected by compression of the tendon with a wad of cotton after its reduction, and by the application of a suitable dressing. In old cases or when the dislocated tendon can not be retained in its normal place, one may, in case there is much disability, replace the tendon by means of an operation, suture the torn tendon sheath, and, if necessary, deepen the malleolus somewhat with a chisel.

Effusions of blood within the tendon sheaths in the neighbourhood of the ankle are very frequently observed after sprains of the latter. They are quickly made to disappear by massage and by active and passive exercise. In old sprains there is frequently serous effusion within the tendon sheaths, with abnormal adhesions of the same. Here also a cure can usually be speedily secured by massage and active and passive exercise.

Among injuries to the nerves of the leg, only those of the peroneal and posterior tibial need to be considered. They are characterized by corresponding motor and sensory disturbances in the foot. The sensory disturbances following the division of one of the two nerves are not constant, because the different branches of the nerves are closely intermingled.

The peroneal nerve supplies the anterior aspect of the leg and the dorsum of the foot. The posterior tibial nerve supplies the posterior aspect of the leg and the plantar surface of the foot. The peroneal nerve divides at its entrance into the peroneus longus muscle, into the musculo-cutaneous and the anterior tibial. The former supplies, besides the skin, the muscles of the peroneal side of the leg, while the latter is the motor nerve of the extensor side of the leg and the dorsum of the foot, and also gives off sensory branches to the borders of the toes. In the foot the peroneal nerve supplies the short

extensor muscles and one or more interossei muscles, counted from the first one.

The posterior tibial nerve, running with the posterior tibial artery, supplies on the leg, aside from the inner portion of the knee and the popliteus muscle, the muscles of the calf and the skin and muscles of the sole of the foot. It passes into the sole of the foot behind the internal malleolus, and here divides into an external and an internal branch, which immediately subdivide into numerous small branches. The cutaneous nerves arising from the peroneal and posterior tibial nerves are closely intermingled in the skin of the leg and the foot. The long saphenous nerve supplies particularly the inner border of the foot.

Paralysis of the peroneal nerve, sometimes of a permanent nature, has been observed as the result of compression of the peroneal nerve near the head of the fibula—e. g., in consequence of applying the adhesive plaster too tightly in putting on an extension apparatus. I saw reflex tetanic spasms in one case after contusion of the peroneal nerve in the middle of the leg, much as in infectious tetanus. I exposed the nerve in the middle of the leg and found its sheath thickened and adherent to the surroundings by means of dense cicatricial tissue. The nerve was separated from its adhesions, and the tetanic muscular spasms ceased immediately and did not return.

The action of the unparalyzed antagonistic muscles do not determine the position of the paralyzed foot in paralysis of the peroneal or the posterior tibial nerve so much as the superimposed weight of the body in walking and the weight of the foot (Hueter, Volkmann). This explains the fact that in paralysis, for example, of the posterior tibial nerve—that is, in paralysis of the muscles of the calf and the sole of the foot—the foot is drawn directly toward the paralyzed side; that is, the foot, simply following its weight, assumes the position of *pes equinus* and supination, while it should, according to the antagonist theory, assume a position of dorsal flexion, in consequence of the contraction of the unparalyzed peronei and extensor muscles (see also §§ 362 and 363).

The treatment of injuries of the nerves of the leg conforms to the same general principles that we have stated fully on page 606 (Injury of the Nerves of the Forearm), and in *Principles of Surgery*, page 469 ff.

Wounds of the arteries of the leg are not infrequent, especially in connection with fractures, gunshot wounds, etc. We follow the principle here also of exposing the artery at the place of injury and tying it proximally and distally.

Ligation of the Anterior Tibial Artery (Fig. 861).—The anterior tibial artery is the weaker terminal branch of the popliteal artery. It

passes between the tubercle of the tibia and the head of the fibula through the aperture of the soleus muscle on to the anterior surface of the interosseous membrane and runs downward upon this in the so-called *canalis fibrosus* (Hyrthl), constantly approaching the tibia. As it descends it becomes more superficial. Above the ankle it lies upon the anterior surface of the tibia, and, passing over the astrago-tibial joint, becomes the *dorsalis pedis* artery. The anterior tibial artery is accompanied by two veins and the anterior tibial nerve.

In the upper and middle third of the leg we find the anterior tibial artery as follows: The leg is rotated inward and the foot placed in plantar flexion. The edge of the tibia is palpated, and to the outer side of this the outer border of the *tibialis anticus* muscle, about two finger breadths distant from the crest of the tibia. The skin incision, six to eight centimetres in length, is made parallel to the outer border of the *tibialis anticus* muscle—that is, somewhat obliquely. After dividing the skin, the subcutaneous cellular tissue, and the fascia, the muscular interspace between the *tibialis anticus* and the *extensor hallucis longus* muscles is opened, by means of the tip of the forefinger or the handle of the scalpel, down to the interosseous membrane. After carefully dividing the sheath of the above-named *canalis fibrosus*, the artery is found between two veins, and the anterior tibial nerve lies on its outer side. The vessels may be brought forward from their deep location, together with the anterior tibial nerve, by means of an aneurism needle, and then the artery isolated. Injury of the anterior tibial nerve would result in a paralytic *pes equinus*, with paralysis of the extensor muscles on the anterior surface of the leg and the dorsum of the foot, including the first interosseous muscle or the second and third also. The *peronei* muscles are supplied by the *musculo-cutaneous* nerve.

In the lower third of the leg the artery lies nearer the bone, as has been said, and more superficially. Here also the fascia is divided and the artery looked for between the tendons of the *tibialis anticus* and the *extensor hallucis longus*. The anterior tibial nerve lies here in front of or to the inner side of the artery.

Ligation of the Dorsalis Pedis Artery is performed as follows: By alternate dorsal and palmar flexion of the foot, or by flexion and extension of the great toe, we palpate the prominent tendon of the *extensor longus hallucis* muscle on the dorsum of the foot below the internal



FIG. 861.—Ligation of the anterior tibial and dorsalis pedis arteries.

malleolus. The skin incision, about four centimetres in length, is made on the outer border of this tendon with the foot in dorsal flexion (Fig. 861). After dividing the skin and the superficial fascia, one works in between the tendon of the extensor hallucis longus and extensor digitorum communis, and immediately finds the artery between the two veins. The anterior tibial nerve lies to the inner side of the artery. The latter is often strikingly weak, and the anterior peroneal artery is then correspondingly more strongly developed.

Ligation of the Posterior Tibial Artery (Fig. 862).—This artery runs downward upon the leg, as the stronger terminal branch of the popliteal artery, to a point midway between the tendo Achillis and the internal malleolus, then beneath the latter under the abductor pollicis muscle to the sole of the foot, where it divides into the external and internal plantar arteries. The artery is accompanied by two veins and the posterior tibial nerve.



FIG. 862.—Ligation of the posterior tibial artery.

If the posterior tibial artery is to be tied in its upper third (Fig. 862), the leg is everted and flexed at the knee joint. The skin incision, about eight centimetres in length, lies from one to one and a half centimetres inward from the inner border of the tibia. After dividing the skin and the fascia, the edge of the gastrocnemius and the soleus muscles is separated from the flexor longus digitorum and reflected backward. One then passes in between the muscles named, with the handle of the scalpel or with the tip of the forefinger, as far as the deep aponeurosis, consisting of tendinous fibres of the soleus muscle and the deep fascia of the leg. After dividing the latter the artery is found between its two veins. The posterior tibial nerve lies posterior to the artery.

If the posterior tibial artery is to be tied behind the internal malleolus, the leg is likewise everted and slightly flexed at the knee joint. The skin incision, from four to five centimetres long, runs midway between the internal malleolus and the tendo Achillis, beginning about a finger's breadth above the internal malleolus, and passing straight downward or around the internal malleolus in a slight curve (Fig. 862). The artery has here a very superficial location, and in the living subject can be felt. After dividing upon the grooved director the skin, the subcutaneous cellular tissue, and the fascia of the leg, which is here strengthened by the internal annular ligament, the artery is found nearer the bone, between its two veins. The posterior tibial nerve lies

nearer the tendo Achillis. The tendon sheaths of the tibialis posticus, the flexor longus digitorum, and the flexor longus hallucis must not be opened, and the mistake should not be made of wandering backward beneath the tendo Achillis.

§ 346. **Fractures of the Shaft of both Bones of the Leg.**—As we have already spoken of fractures of the upper end of the tibia and the fibula on pages 767–769, and shall consider fractures of the malleoli more thoroughly on page 835, in connection with injuries in the neighbourhood of the ankle, we need only occupy ourselves here with fractures of the shaft of the tibia and fibula. Fracture of both bones is most common; and of fractures of a single bone, those of the fibula are more frequent than those of the tibia.

Fracture of both Bones of the Leg occurs most frequently in the middle or lower third or at the boundary between the middle and lower thirds, because the tibia has here the smallest diameter and the bone has the least resistance. This is the most common fracture in hospital practice, no doubt, because the other very common fracture—viz., Colles's—is usually treated in dispensaries. It is most common among men from thirty to fifty years of age, and is very rare among children and old people. The fracture is caused either by direct violence (kick from a horse, being run over, the fall of a heavy body, etc.), or indirectly—e. g., by a fall or a jump upon the feet, or by falling of the upper part of the body, or twisting of the leg when the foot is fixed. Hamilton asserts that he has observed fracture of the leg in four cases also from muscular action alone, but this has not been confirmed by other writers. In indirect fractures the tibia usually breaks first, and then the fibula, from the weight of the body. The latter is usually broken some centimetres higher than the tibia. Direct fractures of the two bones may also be at different levels, but, as a rule, they are broken at the same place. Fractures of the leg are usually complete fractures. Greenstick fractures are very rare. The direction of the line of fracture of the tibia is usually obliquely downward and backward, or downward and inward. The fracture shown in Fig. 863 is a typical oblique fracture (*en bec de flûte* of the French), which occurs particularly on the femur and the tibia. There

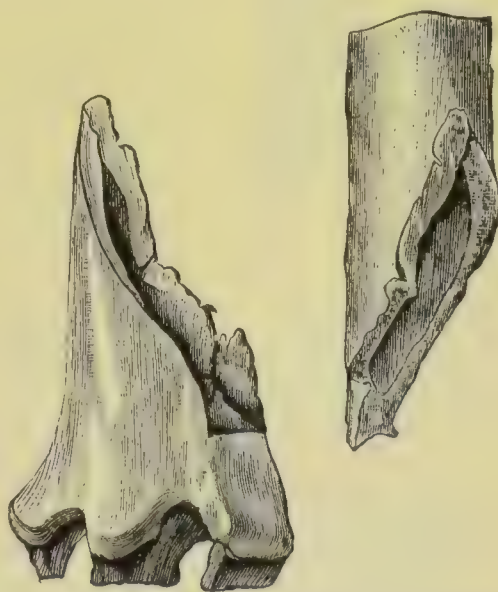


FIG. 863.—Oblique fracture of the tibia (*fracture en bec de flûte*).

is usually a typical displacement in oblique fractures, in that the lower fragment is drawn upward and backward behind the upper fragment by the muscles of the calf. The upper fragment often perforates the skin. The lower fragment is usually everted, because the foot falls outward in consequence of its own weight.



FIG. 864.—Spiral fracture of the tibia (Koch).

As on the femur, so on the tibia also, spiral fractures frequently occur (Fig. 864). They arise from torsion of the leg, and are usually complicated by extensive crushing of the medulla. A spiral fissure very frequently runs into the ankle joint, less often into the knee joint.

Transverse fractures of the bones of the leg are more rare. The fragments are sometimes firmly impacted, or there is angular or rotatory displacement. Gädücke described a longitudinal fracture involving the whole length of the tibia.

The bone is sometimes broken in two places with an intervening triangular or quadrangular fragment. Comminuted fractures with the formation of several loose fragments occur particularly from being run over and from gunshot wounds. The site of the fracture then feels sometimes like a sack filled with crepitating fragments of bone. In the worst cases the bones and the soft parts are crushed to a bloody pulp.

Compound fractures occur very frequently on the leg. They arise not infrequently during the removal of the patient to a hospital if the fragments are not sufficiently immobilized by the first dressing. The amount of injury to the skin varies greatly. There is sometimes only a small punctured wound, and then again the soft parts are severely lacerated, including the blood-vessels, the nerves less frequently. The gunshot fractures of the tibia are sometimes comminuted fractures, sometimes channelled or hole fractures. The bone may be simply divided without fissures and without splintering. In comminuted gunshot fractures the muscles of the calf are severely injured, as a rule, by the splinters of bone.

The symptoms of a fracture of the leg are usually very pronounced, so that the diagnosis is easy. In addition to this, the tibia can be readily palpated owing to its superficial location. The usual signs of a fracture (deformity, shortening, abnormal mobility, and crepitus) are therefore almost always easily made out.

Supramalleolar Fracture of the Tibia and Fibula just above the ankle joint, which is usually opened by the fracture, is of special interest. This fracture seldom arises from direct but most frequently from indirect violence. In indirect fractures—due, for example, to a fall from a height—the astragalus produces the fracture by forcing the malleoli apart, while in fractures due to violent abduction or adduction of the foot the tibia and fibula are broken in part by the astragalus and in part by traction of the lateral ligaments. Separation of the epiphysis sometimes occurs in young children.

Tubby has described five cases, all of which resulted from indirect violence. The patients varied from fourteen to nineteen years of age. In four cases there was posterior displacement of the foot with projection of the shaft forward. As compared with posterior dislocation of the ankle, the relation of the tips of the malleoli to the tarsus and metatarsus is unchanged. The fractures are not infrequently compound.

The deformity consequent upon a supramalleolar fracture varies according to the nature of the displacement. It is the upper fragment in particular which is likely to perforate the skin. The foot generally deviates in one direction or the other with the lower fragment. The differential diagnosis has to be made between fracture and dislocation. In fracture the movements of the ankle are not interfered with, and the malleoli are in normal contact with the astragalus. The deformity can easily be overcome by traction, but returns as soon as the traction ceases. The conditions are quite different in a dislocation of the ankle. The joint is then fixed in a typical position, and the deformity can only be overcome by certain movements. Separations of the epiphysis are observed, as has been said, in rare cases at the lower end of the tibia. There is usually in these cases a projection just above the ankle joint. The exact diagnosis is most easily reached by direct palpation of the bones with the patient under an anæsthetic.



FIG. 865.—Vicious union of a supramalleolar fracture of the leg.

The prognosis of a simple fracture of the leg is favourable. Union follows most quickly (in about six weeks) in transverse fractures. In oblique fractures the union is often slower, and malunion not infrequently ensues. When the union is slow, very marked atrophy of the muscles of the leg frequently develops, so that continued standing and walking are interfered with for a long time, and sometimes permanently. This atrophy of the muscles of the leg is mainly ischæmic, just as on the forearm after dressings have been applied for too long a time and too snugly (see page 612). The ankle

joint may be affected more or less in all fractures of the lower third of the leg. Union with deformity (Fig. 865) is very likely to occur in fractures of the lower third of the leg, especially mild clubfoot or flat foot. Pseudarthrosis results most commonly from the interposition of muscles. The fibula and the tibia are sometimes united by a bridge of callus without impairment of the function of the ankle being always occasioned thereby. The prognosis of compound fractures has been very much improved by the adoption of antiseptic methods in treating wounds. In all compound fractures attention must be paid in the further course to burrowing of pus and a spreading phlegmon.

Treatment of Fracture of the Leg.—Correction of the displacement is the first indication, and this is best accomplished by traction on the foot, counter-traction in the region of the knee, and direct pressure upon the fragments. In some cases an anæsthetic should be given, especially when the muscles are spasmodically contracted. An injection of morphine is also very useful in such cases in place of an anæsthetic or the temporary application of an extension apparatus for two or three hours (Verneuil). The leg and foot must be in such a position that, when the ankle is flexed at right angles, the inner border of the great toe is in a line with the internal malleolus and the inner border of the patella. When the soft parts are extensively lacerated, and there is a marked extravasation of blood and severe swelling, reduction by traction should be performed as carefully as possible to prevent rupture of the tense skin. It is better, in such cases, to wait a few days, until the swelling has diminished somewhat. When reduction of the deformity is impossible with the leg extended, it can often be performed with the knee flexed. Reduction may also be rendered difficult in case the skin and fascia are perforated by a fragment. It may be necessary here to make an aseptic incision. If reduction of the displaced fragments is unsuccessful, or if the displacement easily recurs, subcutaneous tenotomy of the tendo Achillis is then to be recommended or the aseptic nailing of the fragments.

A great variety of splints has been recommended for the treatment of fractures of the leg. If there is marked swelling, a plaster-of-Paris splint should not be put on at once, but some form of temporary splint should be used or the leg may be allowed to lie on its outer side. Splints for immobilizing the limb and for the transport of the patient may easily be improvised (see Fig. 815, page 731) from straw plaiting, from a roof gutter, or from boards—e. g., from three boards running lengthwise and fastened together by a footboard. Volkmann's splint, a double inclined plane, which can easily be made, Petit's (Heister's) box splint, or wire splints, such as those of Bonnet, Roser, Cramer, and others, are very serviceable. For a description of all these forms of

apparatus for immobilizing the limb, the reader is referred to Principles of Surgery, page 202 ff., where most of them are shown. Cramer's flexible tinned splints of iron wire will be found very useful. Lateral wooden splints, with or without a posterior splint, are used a good deal in England—i. e., those of Cline and Sharp. All splints must be well padded with thick, soft woollen felt or cotton. The heel should be relieved of pressure by placing a thick wad of cotton under each malleolus, so that bedsores may be prevented. The bandages used for holding on the splint should also be so applied as to leave the region of the heel easily accessible for palpation.

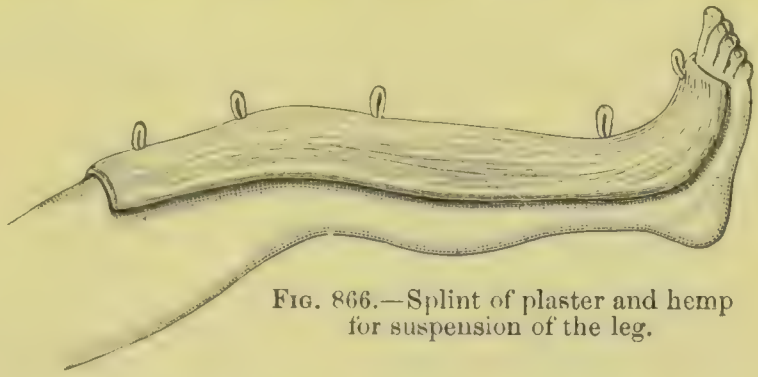


FIG. 866.—Splint of plaster and hemp for suspension of the leg.

After the swelling has subsided a plaster-of-Paris splint is applied in all simple fractures (see Principles of Surgery, page 218 ff.). If there is not much swelling, the plaster splint may be put on immediately after the injury. It extends from the upper third of the leg over the ankle, which is at right angles, to the heads of the metatarsal bones, so that the toes remain free. The heel must be well padded. Suspension by means of Beely's anterior splint of plaster of Paris and hemp (Fig. 866 and Fig. 816, page 732), with the knee joint slightly flexed and the ankle at right angles, is also very serviceable. Extension apparatus similar to those represented in Figs. 817 and 818, pages 732 and 733, are to be recommended in some cases. For the ambulatory splints which have been used of late in treating fractures of the lower extremity, see page 733 (Fractures of the Thigh).

It frequently happens that the upper fragment presses against the skin and threatens to perforate it. Malgaigne's spike was formerly much used in such cases. The upper fragment was held down by this means while the leg lay upon a splint. The use of Malgaigne's spike has properly been abandoned. Aseptic nailing of the fragments is better in such cases, or the resection of the pointed fragment and suture with silkworm gut or silver wire. Tenotomy of the tendo Achillis, which is much practised, especially in England, is often sufficient, because the lower fragment is forced by the muscles of the calf against the upper fragment, so that the latter presses against the skin.

After union of the fracture, which requires from five to eight weeks, use is made of baths, massage, and active and passive exercise of the ankle and the knee. In case the formation of callus is retarded,

it is a good plan to allow the patient to walk about in a splint, so as to hasten the formation of callus by irritation of the ends of the bone. For the treatment of pseudarthrosis see Principles of Surgery, page 603.

The treatment of compound fractures conforms to general rules (see Principles of Surgery, pages 597–602). Suture or aseptic nailing of the fragments may be indicated here, in case the displacement can not be corrected.

The extremity should be elevated in all injuries of the leg and the foot, in order that venous engorgement may be prevented as far as possible.

Fractures of the Leg during Delivery.—Aside from the already mentioned separations of the epiphysis, fractures of the shaft of the leg sometimes occur at birth (Küstner, Fritsch, Büngner) which are worthy of notice, as they usually lead to pseudarthrosis, which often defies all treatment, so that amputation sometimes becomes necessary. Most of these fractures are due to indirect violence, resulting from forcible extraction. Büngner explains the pseudarthrosis which is so frequent as mainly due to defective treatment, the oblique direction of the line of fracture with an angular deformity, the interposition of soft parts, etc. The fragments have been found, in connection with pseudarthrosis, to be strikingly atrophic.

It is of the greatest importance for bony union that the fracture be recognised as quickly as possible after birth and suitably treated. The best treatment is by the use of splints and well-fitting braces. In case of pseudarthrosis Büngner recommends an oblique freshening of the fractured ends, so as to secure the broadest possible wound surfaces at the ends of the bones, and these are united by means of silver wire.

§ 347. **Fracture of the Tibia and the Fibula alone.**—We have already spoken on page 767 of fractures of the upper end of the tibia. For fractures of the internal malleolus the reader is referred to page 835 ff. Fractures of the shaft of the tibia alone are exceptional. The fibula almost always breaks, as we have seen, after fracture of the tibia, in consequence, for example, of the weight of the body. Fractures of the shaft of the tibia alone are most frequently the result of direct violence—e. g., a gunshot wound, a thrust, or a blow. The displacement of the fragments is usually slight, as it is prevented by the fibula, which remains intact. The upper fragment is easily displaced somewhat in a forward direction, owing to the traction of the quadriceps muscle and the contraction of the muscles of the calf. This displacement is of great importance for the diagnosis of this fracture, because the other signs of fracture, aside from the local pain produced by it and the extravasation of blood, may be less pronounced. In addition to the rare complete fractures of the tibia alone, incomplete fractures (greenstick

fractures and fissures) are sometimes observed. The fissures run in a great variety of directions, but more frequently in a longitudinal direction or spirally.

Separation of the lower epiphysis of the tibia sometimes occurs among young persons. P. Bruns found it eleven times among a hundred fractures of the tibia. Tubby mentions five cases combined with fracture of the fibula—all compound—and five cases not combined with fracture, which were likewise in most cases compound. The line of fracture sometimes passes from the epiphyseal line into the shaft. The diagnosis is based especially upon the prominence of the upper fragment of the tibia just above the ankle and upon the usually soft (cartilaginous) crepitus. Corresponding shortening of the tibia, in consequence of arrest of growth, may arise from premature ossification of the epiphyseal cartilage.

The intra-uterine fractures of the tibia, to which attention has again been called recently by Braun, are of special interest. The tibia in such children is found bent in a forward direction below the middle of the bone. The fibula is frequently absent in such cases, and this deficiency stands, no doubt, in a causal relation to the fracture. *Pes equinus*, *pes varus*, or *pes valgus* is sometimes combined with the deformity of the leg. The later increasing shortening is also worthy of notice. It amounted, for example, in two of Braun's adult patients to from seven to eight centimetres.

The treatment of fractures of the shaft of the tibia alone is essentially the same as that of fractures of both bones (see page 816). In simple fractures a plaster-of-Paris splint should be used. Compound fractures are treated under antiseptic precautions and in accordance with general rules (see *Principles of Surgery*, pages 597–602). For the treatment of fractures with retarded callus formation and that of pseudarthrosis see *Principles of Surgery*, page 603.

Fractures of the internal malleolus will be spoken of more fully in connection with injuries of the ankle, dislocations of the same, etc. (see page 835 ff.).

Fractures of the Fibula alone.—For fractures of the head and the upper end of the fibula the reader is referred to page 770. Fractures of the lower end of the fibula (external malleolus) will be described on page 835 ff.

Fractures of the shaft of the fibula in the upper and middle thirds are likewise rare. They also occur occasionally from direct violence, and are usually more difficult to make out on account of the thick muscles of the calf than in the lower portion of the fibula. When the fibula is fractured in the upper or middle third the patient can usually

walk without much pain. The most important symptoms are the localized tenderness at the site of the fracture, and sometimes crepitus upon moving the foot. The upper end of the fibula, moreover, does not move with the foot when the latter is rotated. The fractures usually unite in three or four weeks with a plaster-of-Paris splint. After three weeks massage is begun, and the patient can generally be allowed to walk about. For the antiseptic treatment of the various forms of compound fractures, see *Principles of Surgery*, pages 597–602. For separation of the lower epiphysis of the fibula see page 815. Separation of the lower epiphysis of the fibula alone is very rare. Tubby verified one case by amputation.

§ 348. **Diseases of the Soft Parts of the Leg.**—The acute inflammatory processes on the leg, such as lymphangitis, erysipelas, cellulitis, etc., arise often from ulcers and from very trivial wounds on the toes or at the edge of the nail. Their treatment conforms to general rules (see *Principles of Surgery*). Deeper abscesses of the leg are opened by making a longitudinal incision through the skin and pushing a closed artery clamp or a dressing forceps through an intermuscular space into the abscess cavity.

Furuncles and eczema are rather frequent on the leg. They are worthy of notice in so far as they frequently give rise to varicose ulcers in persons with varicose veins.

Varicose Ulcers of the Leg (see Fig. 867), also called simply ulcers of the leg, often result from inflammations and traumatism of the most trivial sort. By an ulcer is understood, as is well known, a granulating loss of substance in the skin which shows no tendency to heal. The healing of these varicose ulcers of the leg is rendered still more difficult by the circulatory disturbances which usually coexist.

Different kinds of ulcers of the leg are distinguished according to their appearance. Thus, the inflammatory are distinguished from the indolent ulcers according to the intensity of the reactive inflammation. Severe inflammation frequently results when the treatment is not antiseptic, including phlebitis and periphlebitis, with the formation of thrombi in the veins. Metastatic pyæmia may develop from the suppurative breaking down of the thrombi. The form, size, and depth of the ulcers vary greatly. They often involve the greater part of the leg, but are found most frequently in its lower third. The surface of the ulcer is sometimes flat, or it may be depressed or inclined to project above the niveau of the skin. The base of the ulcer may be œdematous, hæmorrhagic, anæmic, or gangrenous and sloughing. The edges are often more or less normal and flat, or they may be elevated and hard, or undermined. These ulcers sometimes increase in size very

rapidly, and phagedenic ulcers may result, especially in connection with syphilis or when the patient neglects them. In other cases the ulcers remain more or less stationary or increase in size very slowly. Serious or even fatal hæmorrhages sometimes occur if prompt surgical aid is not at hand. In case of ulcers of long standing the skin and subcutaneous cellular tissue may be enormously hypertrophied (elephantiasis).

Of other ulcers of the leg there are to be mentioned the tropho-neurotic ulcers in connection with paralysis and other diseases of the nervous system, the lupoid (tubercular) and syphilitic ulcers, diabetic ulcers, and finally the decubitus ulcers on the heel. The syphilitic ulcers are sometimes cutaneous ulcers, occurring in the secondary stage of syphilis, or they may be due to the breaking down of gummata, especially on the tibia. Phagedenic ulcers are sometimes observed—e. g., in lupus and syphilis—which increase in size more or less rapidly.

The diabetic gangrene of the lower extremity owes its origin usually, even among young persons, to a simultaneous arterio-sclerosis of the vessels, with thrombosis of the same, as in senile gangrene (Israel, König, E. Küster, L. Heidenhain, the author).

The treatment of ulcers of the leg is partly local and partly constitutional, in case, for example, of syphilis, tuberculosis, nervous diseases, etc. The cause of the ulcer is therefore to be definitely determined in each case. The local treatment always conforms to antiseptic principles. Dressings of iodoform, bismuth, zinc oxide, naphthaline, acetate of aluminium, or antiseptic ointments (boracic ointment, zinc oxide, etc.), are very serviceable. Sloughing phagedenic ulcers should be scraped with a sharp spoon, and their edges removed or cauterized with caustic potash, Paquelin's cautery, or the galvano-cautery. Elevation of the leg is of the greatest importance in treating large ulcers. The leg should be well supported by a bandage in case the patient walks about. Martin's rubber bandage, which was formerly much used, is generally not endured. If the ulcer can not heal because its callous edges are not sufficiently movable, concentric incisions may be made around the ulcer to allow it to contract. The incisions should be made at a distance of one to three centimetres from its border and parallel to it, and pass through the entire thickness of the skin down to the fascia. Excellent results are secured in the treatment of large ulcers by scraping the base of the ulcer, freshening its edges and skin-grafting it, either immediately upon arresting the hæmorrhage or on the next day. Recurrences are best prevented thereby. The healing in of pedunculated flaps from the immediate neighbourhood or from

more remote parts of the body (see Principles of Surgery, pages 138–141) has been more and more superseded by Thiersch's skin-grafting (see Principles of Surgery, page 141). One is obliged not infrequently to remove with the chisel the hypertrophic or necrotic bone that lies at the bottom of the ulcer, any fistulæ are to be divided, etc. Very far advanced ulcers may be treated by resecting a piece of bone from the continuity of the tibia and the fibula (Jasinski, Löbker, Martel). Amputation is indicated in rare cases. When suitable—e. g., in deep ulcers on the anterior surface of the leg—Rydygier's operation may be substituted for high amputation of the leg. This is similar to Pirogoff's amputation of the foot, with the difference only that the plantar incision is not made, but the entire length and thickness of the sole as far as the toes is detached in the form of a flap, and this is used for covering the ulcer after the anterior bridge of skin in the region of the ankle and the leg has been divided in the median line. The two flaps of this bridge of skin are also employed, it may be, for covering the ulcer. Keetley modified Syme's operation in a similar manner and for the same purpose.

In case of deep gangrene of the leg, amputation is always to be performed as far as possible from the focus of disease—that is, high amputation of the femur is usually indicated (for particulars see § 361, pages 869, 870).

Varicose Veins of the Leg.—The leg and the lower extremity in general are the favourite location for varicose veins, and they occur most commonly among multiparous women, and in general where there is difficulty in the return of venous blood to the heart. The development of varicose veins is favoured by changes in the walls of the vein and its surroundings, which is often inherited. They are very often to be looked upon as an affection due to one's employment, when they develop as the result of constant standing.

The symptoms consist above all in the dilatation over larger or smaller areas of the subcutaneous veins, and also the deeper veins within the muscles—e. g., in the calf. This dilatation of the veins is in part uniform and in part fusiform or sacciform, and they are visible as bluish stripes or convolutions beneath the usually thin skin (Fig. 867). Death has repeatedly been observed from hæmorrhage resulting from rupture of varicose veins and the thin skin lying over them, because people without medical knowledge do not usually know what to do in such cases. They are often combined with phlebitis and periphlebitis—e. g., in consequence of infection of small fissures in the skin of the toes or from varicose ulcers of the leg. Extensive thrombosis may result in such cases, and death from metastatic pyæmia may

occur in consequence of suppurative breaking down of these thrombi. This phlebitis and periphlebitis are observed also in case of varicose veins within the muscles of the calf. The latter swells rapidly and becomes firm and very painful. I saw sudden death from embolism of the brain in a man with thrombosis of the veins of the calf muscles after massage, which had been given in consequence of a wrong diagnosis. Massage is contraindicated in case of thrombosed varicose veins, and especially of varicose veins of the calf muscles. The so-called phleboliths are due to the fact that the thrombi become chalky and calcified. We have already spoken above on page 820 of the varicose ulcers of the leg, which are so frequently the result of varicose veins of the lower extremity. Cramps in the leg are often conditioned upon varicose veins within the calf muscles.

The treatment of varicose veins consists in bandaging the extremity and in the use of elastic stockings. Martin's rubber bandage is usually not endured for any length of time. It is very likely to produce troublesome eczema. Attention must be paid to any special causes (tumours of the inguinal region, heart disease, etc.). P. Vogt recommended hypodermic injections of ergotin. The dilated portions of the veins may be excised after previous proximal and distal ligation with catgut, or they may be tied off subcutaneously. The latter operation is performed by carrying a catgut ligature behind the vein by means of a curved needle and tying it over the skin—e. g., over a drainage-tube, a small roll of iodoform gauze, etc. Recurrences have frequently been observed even after excision. Trendelenburg secured very good results from double ligation of the internal saphenous vein between the lower and middle thirds of the leg, with subsequent division between the ligatures. Excision of the enlarged veins may be combined with ligation of the internal saphenous. Landerer recommends compression of the saphenous vein by means of a trusslike bandage.

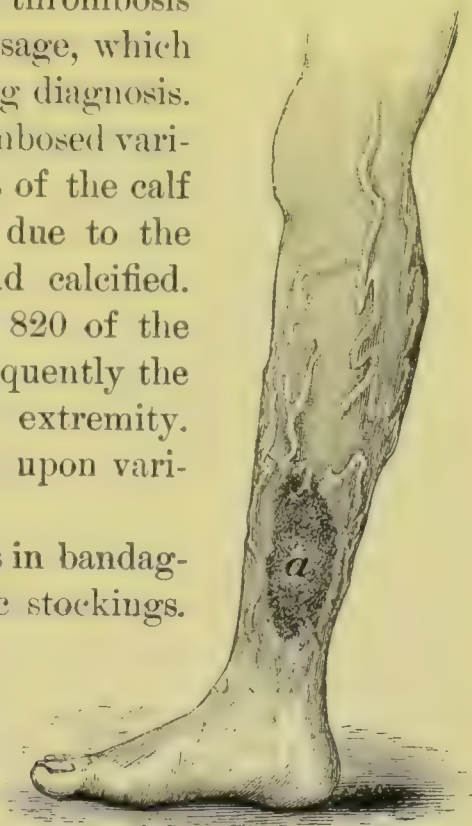


FIG. 867.—Varicose veins of the right leg: *a*, varicose ulcer.

Lymphangiectasis of the Leg.—Dilatation of the lymph vessels, or lymphangiectasis, occurs under much the same conditions as that of the veins, in consequence of obstruction to the flow of the lymph. Lymphangiectasis is also observed after the greatest variety of recurrent inflammations. The lymph passages are so numerous, however, that in case of an engorgement

of lymph there is usually a compensation. By the bursting of a varicose lymph vessel a so-called lymphatic fistula may be formed, and the escape of lymph (lymphorrhœa) may be considerable, especially when the female external genitals are involved.

The hypertrophy of the skin and the subcutaneous cellular tissue on the lower extremity, so-called elephantiasis, is conditioned mainly upon lymphangiectasis. It occurs most frequently on the lower extremity and on the external genitals. The hypertrophy of tissue is in part a result of frequently recurring inflammations of the leg and foot, but it is to be regarded as in part a specific infectious disease which is endemic in tropical and subtropical regions (Central America, India, Arabia), but only sporadic in Europe (see particulars in Principles of Surgery, page 522). The enlargement of the lower extremity and of the scrotum may be very marked in this latter form of true elephantiasis (*elephantiasis Arabum*).

The treatment of lymphangiectasis is, generally speaking, the same as that of varicose veins (bandaging the leg, elevation, cauterization with the fine point of a Paquelin cautery or the galvano-cautery, etc.). Lymphatic fistulae have been cured by transverse division of the skin above the fistula. The treatment of the existing hypertrophy of tissue, the elephantiasis, is directed especially against any inflammatory processes. If the latter are no longer present, the hypertrophy of tissue is treated by the use of rubber bandages or elastic stockings, by repeated excision of spindle-shaped pieces of skin, by the use of the thermo-cautery or galvano-cautery, and, in severe cases, by ligation of the femoral artery. Remarkably good results have been secured by the latter method. Amputation or disarticulation of the involved extremity may become necessary in the most extreme cases.

Tumours.—Tumours in a great variety of forms occur occasionally upon the leg, but they are not common. Fibromata and sarcomata are the most frequent. Very painful neuro-fibromata are sometimes observed, which proceed chiefly from the cutaneous nerves. In the course of development of a round-celled sarcoma on the leg, as large as a child's head, I saw numerous sarcomata the size of a bean, a cherry, a walnut, or a small apple, on both the lower extremities, which disappeared again for the most part, in the course of six months, from fatty degeneration, while the primary sarcoma increased more and more in size.

Epitheliomata sometimes develop in old ulcers of the leg of large size among people advanced in years. They have also been observed in fistulous tracts and in cicatrices—e. g., after necrosis of the tibia. Amputation as far as possible from the upper limit of the epithelioma (at least five or six centimetres) is indicated in all such cases, and if no lymphatic glands in the inguinal region are as yet diseased, the prognosis regarding a recurrence is, generally speaking, favourable. For a description of gummata, see page 830.

§ 349. **Diseases of the Tibia and the Fibula.**—Among congenital malformations, defects, particularly of the lower end of the tibia and the fibula, with corresponding deformity of the ankle joint, deserve special mention (see Figs. 897, 898, page 874). Such defects may be restored by cutting a strip of bone of the proper size from the other

bone. In case of complete absence of the tibia the fibula may be united to the lower end of the femur at the intercondyloid notch, and the supporting power of the leg improved by arthrodesis at the ankle. Among inflammations of the bones of the leg acute osteomyelitis is very common, and is most likely to attack the femur and tibia in young children, particularly in the region of the epiphyses. For the etiology, course, and treatment of acute osteomyelitis, which, as is well known, sometimes involves the neighbouring joints and causes separation of the epiphyses, and hence disturbance of growth in the tibia and femur, the reader is referred to a full account of the subject in *Principles of Surgery*, pages 610 and 614.

Grayish-white or more yellowish softened areas with increasing painful thickening of the bone sometimes develop in the tibia after acute osteomyelitis, in consequence of the presence of staphylococci, which have been left behind. In such cases, which usually have a chronic course, the bone is to be chiselled open and scraped out to a sufficient extent.

Acute osteomyelitis is sometimes followed by a localized chronic bone abscess. These chronic bone abscesses (see Fig. 853, page 800) have a very varied etiology. Aside from acute osteomyelitis that has just been mentioned, they may develop after acute infectious diseases—e.g., typhoid fever. Others of them are of tubercular or syphilitic origin. The diagnosis of an abscess within the bone is based upon the history of the patient, upon the enlargement and tenderness of the bone, which are always present, and upon the changed percussion note of the latter (Lücke). The treatment consists in chiselling the bone open freely and scraping it out. If the abscess breaks through into the knee or the ankle, arthrotomy and drainage or resection of the joint are indicated.

Necrosis is very frequent, especially in the tibia, and results sometimes from traumatic and sometimes from inflammatory causes, especially from suppurative periostitis and osteomyelitis. The separation of the dead bone, of the sequestrum, is the result of a demarcating rarefying ostitis or absorption of the bone at the boundary between the living and dead bone. The time required for this process of demarcation—this complete separation of the sequestrum—is variable. It depends upon the size and the location of the sequestrum, and may cover weeks or months. A sequestrum consisting of the whole shaft of the tibia sometimes takes from three to five months, and in other cases from eight or ten months to a year, to become separated. Regeneration of the bone by ossifying periostitis and osteomyelitis goes hand in hand with the separation of the dead portion. The sequestra are surrounded

by a bony covering, the so-called involucrum, which is formed by ossifying periostitis of the detached periosteum. The fistulæ leading outward from the involucrum are called cloacæ. The tibia and the fibula have, generally speaking, a very marked power of regeneration. It is sometimes defective, however, and may even be absent altogether. Increased longitudinal growth is not infrequently observed in connection with necrosis of the bones of the leg, especially of the tibia, in consequence of irritation of the epiphyseal cartilage, so that the leg becomes two or three centimetres longer than the sound one (see also page 829). The necrosis of the tibia and fibula may be either external and superficial or central, or it may affect the entire thickness of the bone. In rare cases we have to do with complete necrosis of the entire shaft. There are sometimes multiple necrotic areas in different parts of the tibia and fibula. In one form of necrosis a cylindrical sequestrum is formed in the substance of the bone, which is surrounded by sound bone on its inner and outer surface. Small sequestra may be completely dissolved, as it were, if suppuration is absent and the granulation tissue closely surrounds the sequestrum. The lime salts are dissolved, in such cases, by the carbonic acid formed by the metabolism of tissue, while the remaining soft ground substance undergoes degeneration.

The diagnosis of necrosis is based upon the existing thickening of the bone, upon the presence of fistulæ, and, above all, upon finding the sequestrum by probing the fistulous tracts. The dead bone is of a white colour, and gives a tympanitic sound when touched with the probe. It feels hard, and in superficial and complete necrosis it is smooth. As soon as the sequestrum becomes completely detached, it is movable.

The treatment of necrosis consists in the removal of the completely detached sequestrum. One must wait until it is wholly separated, because the loss of substance in the bone is then usually compensated for by new growth of bone, and because one might, by removing it too early, take away too much of the sound and too little of the dead bone. It is only in exceptional cases that one should not await the separation of the sequestrum—e. g., when there is profuse suppuration, which is endangering the patient's life. The sequestra are sometimes cast off spontaneously, or they may have so superficial a location that they can be extracted through the fistula with forceps, or removed after enlargement of the fistula by dividing the skin. If, however, as is usually the case, the sequestrum is inclosed by an involucrum, its removal then consists in performing a typical sequestrotomy—that is, the soft parts are divided in the region of the fistulæ, the periton^{ste}~~um~~ elevated, the bone

chiselled open to a sufficient extent with hammer and chisel, and the sequestrum extracted. The operation is performed with the use of an Esmarch bandage. After removal of the sequestrum the bone cavity is thoroughly scraped out and the edges of the bony gutter are cut away with the chisel. The after-treatment varies. The bone cavity may first be packed with iodoform gauze and skin-grafted within a few days or later. Healing under the moist blood clot, after Schede, is a very good method in some cases, if the operation has been performed under strict asepsis. In this method the superficial wound is sutured over the bone cavity, without drainage, either completely or with the exception of its upper angle, and the bone cavity is allowed to fill with blood. An antiseptic dressing is applied, and the leg is placed upon a Volkmann splint and in an elevated position.

For osteoplastic necrotomy, after Lücke and Bier, see Principles of Surgery, page 636.

I healed a large defect in the tibia by the implantation of small pieces of bone containing periosteum and medulla taken from a recently killed young rabbit (Fig. 868). In another similar case I obtained an equally good result by using pieces of bone which had been removed in the performance of a necrotomy. In such cases the implanted bone probably serves merely as a temporary filling material.

In a case of extensive necrosis without regeneration of the tibia Mikulicz restored a defect fifteen centimetres in length by treatment with turpentine. The periosteum was detached from the bone at its upper and lower end and the cicatricial band between the ends of the bone was divided in halves longitudinally and also laterally by means of several lateral incisions. Gauze saturated with turpentine was laid between the incised surfaces, and this was renewed every four or five days. In nine months the entire defect was filled with solid

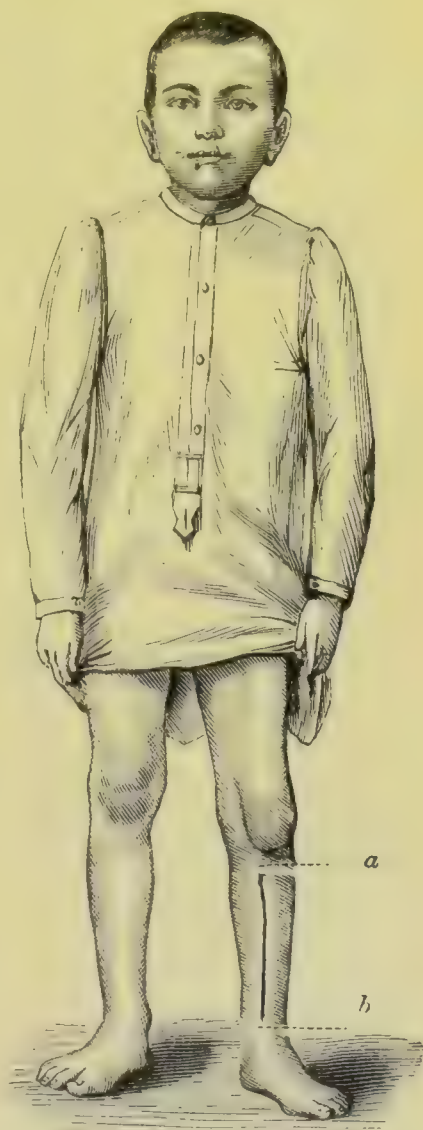


FIG. 868.—Necrosis of the entire shaft of the left tibia following acute suppurative osteomyelitis with extensive burrowing of pus in the vicinity of the knee joint. Restoration of the shaft by the implantation of small pieces of bone taken from a young, freshly killed rabbit. The mobility of the knee joint became subsequently normal.

bone. Defects in the tibia can also be compensated for by corresponding resection of the fibula.

Spontaneous Separation of the Epiphyses occurs especially on the tibia, in consequence of suppurative inflammation of the periosteum, the medulla, and the joints, also after primary inflammations of the epiphyseal cartilage—e. g., from syphilitic chondro-ostitis, likewise in the course of pyæmia and in scurvy. Spontaneous separation of an epiphysis has not been observed as yet in a person over twenty. The symptoms and treatment are the same as in fracture. It is not always attended by disturbance of growth.

Rhachitic Curvatures of the Bones of the Leg (Fig. 869).—In most cases there is a curvature of the tibia near the upper or lower epiphysis.



FIG. 869.—Rhachitic curvature of the legs.

A curvature near the upper epiphysis may be taken for a dislocation of the tibia backward (Sonnenburg, Kirmisson), and there is usually a similar curvature in the region of the lower epiphysis of the femur (*genu varum*, bowlegs). In other cases the tibia and fibula are curved more as a whole and not bent at an angle at a definite place. The bone is usually flattened laterally in all rhachitic curvatures of the tibia. The convexity of the curve is most frequently directed outward, sometimes forward, and less frequently inward. For the nature of rhachitis, see *Principles of Surgery*, page 641 ff.

Treatment of Rhachitic Curvatures of the Leg.—In the majority of cases in children from two to six years of age a gradual cure can be brought about by suitable (antirhachitic) treatment and by the use of braces.

Operative measures should be resorted to only in older children—from the seventh or eighth year on. As long as the bone is soft it can be straightened under an anæsthetic without breaking it. In other cases the curved bones, especially the tibia, have to be partially or completely broken with an osteoclast or the hands, and the leg put up in a plaster splint for from three to five weeks.

In older children bending or fracture of the bones of the leg is usually difficult, and it is not easy in a child four years of age. For this reason aseptic osteotomy with the hammer and chisel is decidedly to be preferred. The bent portion of the tibia is exposed by a transverse incision through the skin and the periosteum, and the bone is then chiselled through, with the exception of a small rem-

nant, which is broken with the hand, as is also the fibula. Linear osteotomy is usually sufficient, but in extreme cases a wedge is chiselled out, whose apex is directed toward the concavity of the curva-

ture. The wound is left open, an antiseptic protective dressing applied, and a plaster-of-Paris splint put on, which remains for from four to six weeks, until union takes place. Children sometimes walk badly after recovery, as Gussenbauer has correctly stated, so that braces are necessary until the knee and ankle have accommodated themselves to the changed line of direction of the weight of the body.

For osteomalacia, atrophy and hypertrophy, as well as giant growth of the bones of the leg, the reader is referred to *Principles of Surgery*, pages 644-650.



FIG. 870.—Increased longitudinal growth of the right femur amounting to two centimetres and a half which resulted from a phlegmon of the thigh.



FIG. 871.—Increased longitudinal growth of the right femur and tibia amounting to three centimetres which resulted from tubercular arthritis of the knee.

Increased longitudinal growth of the bones, especially of the femur and the tibia, sometimes follows irritation of the epiphyseal cartilage, in consequence of injuries and diseases of the shaft, of the neighbouring joints, and of the soft parts—e. g., after compound fractures, which unite with considerable inflammatory reaction; also after necrosis, osteomyelitis, ulcers of the leg, intermuscular suppurations, and chronic diseases of the joints (Figs. 870, 871). The bones are not only longer but thicker also. The difference in length is usually compensated for afterward. Ollier, in particular, has proved experimentally that young bones show increased growth after comparatively slight irritations—e. g., from driving ivory pins into the shaft. In the case of a student eighteen years of age, who had fought a duel with pistols, I observed a severe crushing of the tibia and fibula with extensive splintering. There was at first a shortening of five centimetres. When I saw the patient again, a year later, I was not a little astonished to find that this shortening had been for the greater part compensated for by increased longitudinal growth. It then amounted only to a centimetre and a half or thereabouts. Young

bones that have been dislocated and not reduced show increased longitudinal growth when they are freed from the pressure of the bone that is opposed to them. The same thing is observed on the femur in case of contracture of the knee joint. Ollier and others have utilized these facts in order to overcome shortening of the bones by irritation of the epiphyses—e. g., by driving in ivory pins, by the excision of periosteum, or by osteotomy.

For tumours of the bones of the leg the reader is referred to page 739 ff. (tumours of the femur) and to pages 799–802 (tumours of the bones in the region of the knee joint). I need mention here only the gummata, which occur especially on the anterior surface of the tibia. They either disappear spontaneously, or under suitable antisyphilitic treatment (see Principles of Surgery, page 433 ff.), or break down and form ulcers. Gummata originate in part in the skin and in part in the periosteum or medulla. Patients with gummata of the bone often suffer a great deal of pain, particularly at night.

§ 350. Amputation of the Leg.

—Amputation of the leg is usually performed by the circular method, or, if necessary, by the flap method. The operation may be performed at any height, up to the tubercle of the tibia. Three large arteries (the anterior and posterior tibial and the peroneal) and several muscular branches have to be tied.

Circular Amputation (after Pet-
it).—The operator stands so that the leg which is to be amputated is on his right side; that is, in amputating the right leg he stands outside of it, and in amputating the left leg on the inside. After applying Esmarch's bandage and tube the skin is divided down to the fascia by a circular cut. The skin is then dissected up from the fascia, and the cuff of skin is reflected upward. The length of this cuff should equal half the diameter of the leg. If the cutaneous cuff can not be reflected properly, owing

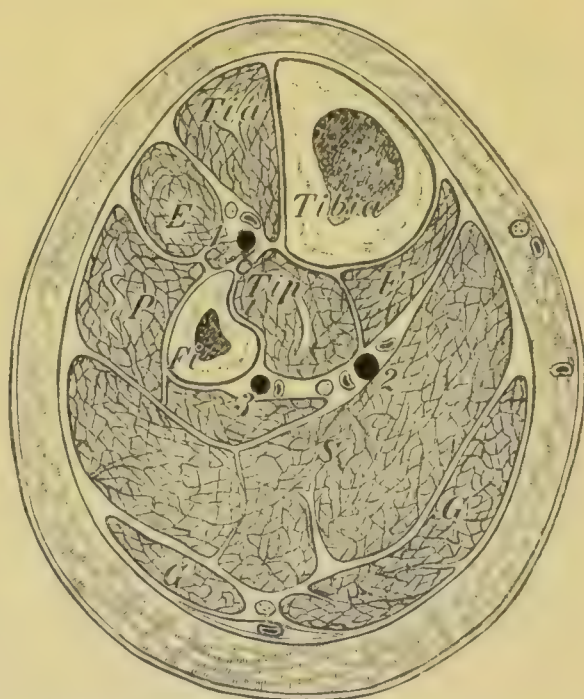


FIG. 872.—Transverse section through the middle of the right leg: 1, anterior tibial artery and nerve; 2 and 3, posterior tibial and peroneal arteries and posterior tibial nerve which are separated from the anterior tibial artery by the tibialis posticus muscle (*Tip*). *Tia*, tibialis anticus muscle; *E*, extensor digitorum and extensor hallucis longus muscles; *P*, the peronei muscles; *S*, soleus muscle; *G*, the two heads of the gastrocnemius with the external saphenous vein and nerve. In front of the soleus on the fibular side lies the flexor hallucis longus, and on the tibial side the flexor digitorum communis. The internal saphenous vein and nerve lie on the inner side of the leg in the subcutaneous cellular tissue.

to a rapid increase in the size of the limb, a short longitudinal incision is made either on one or both sides. All the muscles are divided to the bone by a circular incision close to the reflection of the cuff. The soft parts between the bones are then divided by a narrow double-edged knife, which is inserted first from one side and then from the other, and the edge of the knife directed first against the tibia and then against the fibula. The soft parts are retracted upward by means of a split aseptic compress, and the bones are sawn. The tibia is first sawn partially through, and then both bones are finally sawn through together. The posterior edge of the tibia is removed obliquely with the saw or the chisel, in order that gangrene of the skin from pressure may be avoided. The arteries (anterior and posterior tibial and peroneal) and several muscular branches are tied. The location of the three large arteries is shown in Fig. 872.

The larger nerves are drawn out with forceps and cut off with scissors. The wound is drained through the posterior (lower) portion of the cuff of skin, sutured, and dressed.

The Cutaneous Flap Amputation is less used, though individual surgeons have a special preference for this or that form of flap. At the lower third of the leg two lateral flaps may be used. If an anterior overhanging flap is preferred, the edge of the tibia must be sawn off, as we have just said, in order that gangrene of the flap from pressure may not ensue. To avoid the latter, Langenbeck suggested, especially for the upper two thirds of the leg, the formation of a lateral flap from the inner side of the leg (Fig. 873). The knife is inserted to the depth of one centimetre near the anterior edge of the tibia at the point where the leg is to be amputated, and is carried directly downward. The posterior longitudinal incision on the calf is then made, and the two longitudinal incisions are united. The periosteum of the anterior surface of the tibia is included in the flap. After the flaps have been formed the muscles are divided as above by a circular cut. With a view to avoiding necrosis of the soft parts from pressure, Bose considers it important that the periosteum on the anterior surface of the tibia be preserved. After a circular incision through the skin, Bose forms an inner and an outer quadrilateral cutaneous flap by making a longitudinal incision a finger's breadth outward from the anterior edge of the tibia, and another directly opposite on the posterior aspect of

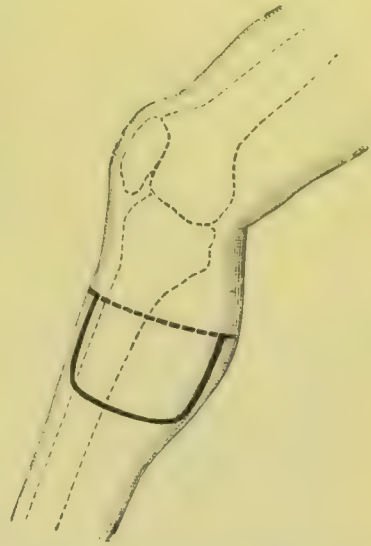


FIG. 873.—Amputation of the leg by the formation of an internal lateral flap.

the leg. The fascia and the periosteum upon the anterior surface of the tibia are then transversely divided and included in the flaps.

Mosetig-Moorhof forms two lateral skin-muscle flaps which unite in front at the inner edge of the tibia and behind in the middle of the calf. The flaps are sutured from behind forward. The excess of skin of the broader outer flap is laid over the edge of the tibia in the form of a transverse fold in order to avoid necrosis from pressure.

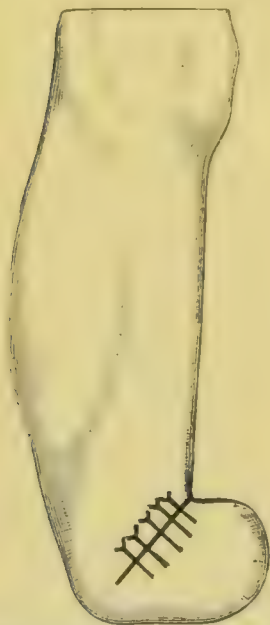


FIG. 874. — Osteoplastic amputation of the leg with the formation of an artificial foot (Bier).

P. Bruns recommends the following (subperiosteal) method of amputation, which insures very good stumps and obviates gangrene of the flap: The skin is drawn well upward and a circular incision is made down to the bone and a longitudinal incision at the inner edge of the tibia and another at the outer edge of the fibula. Then follow detachment of the tibia and fibula from their covering of periosteum, so that the latter is preserved intact. The soft parts are then retracted and the bones are sawn off, the tibia being sawn obliquely in order to make the anterior edge slanting.

Bier has attempted in low amputations of the leg to make the stump more useful by sawing out a triangular wedge from the tibia, the apex of the wedge being directed backward, thus forming a sort of artificial foot. The lower end of the tibia is united at right angles with the sawn-off portion after removal of the lower end of the fibula (Fig. 874). The operation should be performed in two stages—that is, after the patient has recovered from the amputation the artificial foot is formed.

CHAPTER XXXV.

INJURIES AND DISEASES OF THE ANKLE AND THE FOOT.

Anatomy of the ankle and tarsal joints.—Malleolar fractures.—Sprains of the ankle joint.—Dislocations of the foot (tibio-tarsal dislocations).—Subastragaloid dislocations.—Isolated dislocation of the astragalus and of the other tarsal bones.—Dislocation of the metatarsal bones and of the toes.—Fractures of the bones of the foot.—Wounds of the articulations of the foot, especially gunshot wounds.—Inflammations of the ankle, of the bones and joints of the tarsus, of the metatarsus, and of the toes.—Metatarsalgia.—Arthritis urica (gout).—Inflammatory processes in the soft parts of the foot.—The different varieties of gangrene.—Syphilitic ulcers of the toes.—Ingrowing toe nail.—Onychogryphosis.—Onychomycosis.—Blisters from pressure.—Calluses, corns, chilblains, etc.—Congenital and acquired deformities.—Hallux valgus.—Contractures of the toes.—Pes equinus.—Pes calcaneus.—Pes varus (clubfoot).—Pes valgus (flat foot).—Tumours of the foot.

Operations on the ankle and the foot.—Resection of the ankle.—Arthrodesis.—Resection of the tarsal bones.—Mikulicz's amputation.—Resection of the metatarsal bones and of the toes.—Disarticulation of the toes.—Amputation through the metatarsus.—Disarticulation of the toes with the metatarsal bone.—Amputations after Lisfranc, Chopart, Malgaigne, Pirogoff, etc.—Osteoplastic operations on the foot.—Syme's amputation.—Technique of bandaging the ankle and the foot (see Principles of Surgery, §§ 50–55).

§ 351. **Anatomy of the Ankle and Tarsal Joints.**—The most movable of all the articulations of the foot are the astragalo-tibial and the two astragalo-tarsal joints. The remaining articulations of the tarsal bones with one another and with the metatarsal bones are amphiarthroses.

1. **The Ankle or Astragalo-tibial Joint.**—The convex surface of the trochlea of the astragalus fits exactly into the inferior surface of the tibia, which is concave from before backward. The synovial membrane sends a duplicature upward between the tibia and the fibula as far as the tibio-fibular ligament which unites the two bones. This articular cleft between the tibia and the fibula has also been designated as the inferior tibio-fibular joint. The tibia and fibula form a mortise to receive the upper convex surface of the astragalus and its two facets. The external malleolus extends much farther downward than the internal malleolus. The capsule of the astragalo-tibial joint is strengthened on the outer side by the external lateral ligament, and on the inner side by the stout internal lateral or deltoid ligament which extends from the inner malleolus to the inner surface of the astragalus and the os calcis. The internal lateral ligament consists of several fasciculi—viz.,

the astragalo-scaphoid, which is the most anterior and superficial, the calcaneo-tibial, and the anterior and posterior astragalo-tibial ligaments.

The movements of the foot at the ankle joint consist in flexion (plantar flexion) and extension (dorsal flexion), whereby the astragalus moves with the foot about a transverse axis. This range of movement amounts, according to the measurements of the Weber brothers, to about seventy-eight degrees, and when the foot is at right angles the range of flexion and that of extension are about the same. Dorsal and plantar flexion are checked, especially by the contact of the anterior and posterior edges of the tibia or the inner malleolus with the astragalus and by the lateral ligaments, especially the anterior and posterior fasciculi of the external lateral ligament and the anterior and posterior tibio-tarsal ligaments. Plantar flexion is checked by the anterior ligaments and dorsal flexion by the posterior ligaments. The muscles also have a share in the limitation of the movement—e. g., the gastrocnemius in checking dorsal flexion. This explains the fact that dorsal flexion of the foot is more free when the knee joint is flexed—that is, when the gastrocnemius is relaxed—than when the leg is extended.

2. The Astragalo-tarsal Joint.—The astragalus is connected with the tarsus by the astragalo-tarsal joint. This articulation is made up of an anterior



FIG. 875.—Sagittal section through the tarsus: 1, calcaneo-astragaloid joint; 2, calcaneo-astragalo-scaphoid joint; A, astragalus; Ca, calcaneus; S, scaphoid; Cu, cuboid; CII, second cuneiform; CIII, third cuneiform.

and a posterior part. The posterior portion is called the calcaneo-astragaloid articulation (Fig. 875, 1), and the anterior portion the calcaneo-astragalo-scaphoid articulation (Fig. 875, 2). Both these joints have a separate capsule and separate ligaments. The calcaneo-astragalo-scaphoid joint is in the same line with the calcaneo-cuboid (Fig. 875), and both joints together are also called Chopart's joint, as it is through this joint that Chopart's amputation is performed (see § 370).

Abduction, adduction, pronation (elevation of the outer border of the foot), and supination (elevation of the

inner border of the foot) are all possible in the astragalo-tarsal joint. The anterior and posterior portions of this joint are to be regarded functionally as one joint. Supination—that is, elevation of the inner border of the foot—is combined with inward rotation of the foot (adduction), and pronation is combined with outward rotation of the foot (abduction). In pronation and supination the foot is rotated about the sagittal axis, while abduction and adduction take place about a vertical axis. This abduction and adduction of the foot should not be confused with the same movements which are brought about by rotation of the whole lower extremity at the hip joint. If the scaphoid moves by itself alone it can produce only to a slight extent movements of abduction and adduction, with pronation and supination of the foot, and contribute but little to plantar and dorsal flexion. The tibialis posticus muscle is of great importance, according to Henle, for the move-

ments of the calcaneo-astragalo-scaphoid joint. Its tendon passes beneath the membranous portion of the concavity and helps support the head of the astragalus. When this muscle is relaxed the head of the astragalus sinks downward and the arch of the foot disappears—that is, flat foot ensues.

Pronation, supination, abduction, and adduction in the two parts of the astragalo-tarsal joint are checked mainly by the contact between the astragalus and the os calcis, also by the stout connecting ligaments between the astragalus and the os calcis on the one side and between the os calcis and the cuboid on the other side.

3. The Remaining Articulations of the Tarsus.—But slight ranges of movement are possible in the other tarsal joints. Rotation (pronation and supination) is possible to a limited extent in the articulation between the cuboid and the os calcis (see Fig. 875).

The scaphoid is connected in front by a common capsule with the three cuneiform bones and the cuboid. This joint usually communicates between the first and second cuneiform bone with the second tarso-metatarsal joint.

4. The Tarso-metatarsal Joint, between the three cuneiform bones and the cuboid on the one side and the five metatarsal bones on the other side, usually consists, according to Henle, of three joints provided with a special capsule—viz., first, the joint between the first cuneiform bone and the metatarsal bone of the great toe; second, the joint between the second and third cuneiform bones and the second and third metatarsal bones; and third, the joint between the cuboid and the fourth and fifth metatarsal bones. The second of these joints communicates with that between the scaphoid on one side and the cuboid and three cuneiform bones on the other side. The tarso-metatarsal joints permit mainly a change in the transverse diameter of the arch of the foot.

The articulations between the metatarsal bones and the toes and the individual joints of the toes are analogous to those of the upper extremity.

§ 352. **Fractures of the Malleoli.**—Fractures of the internal and external malleolus, whose origin has of late been studied experimentally, especially by Tillaux and Hönigschmied, arise most commonly from violent pronation and supination—that is, eversion and inversion, with or without abduction and adduction. We saw on page 834 that pronation and supination take place mainly in the astragalo-tarsal joint. There ensues, according to the degree of the violence that is exerted or according to the extent of these movements, either a simple sprain of the ankle joint and of the astragalo-tarsal joint, or a fracture of the malleoli, or, finally, a dislocation of the above joints with or without fracture.

Fractures of the internal and external malleolus resulting from violent inversion, eversion, abduction, and adduction, are either caused by traction of the stout lateral ligaments of the ankle joint (*fracture par arrachement* of the French), or the malleolus is crushed or partially broken off by the lateral surface of the astragalus (*fracture par divulsion* of the French).

In inversion and adduction of the foot the external lateral ligament, the anterior and posterior astragalo-fibular ligaments, and the calcaneo-fibular ligament are stretched, and are either ruptured or they tear off the external malleolus transversely or obliquely, about a centimetre or a centimetre and a half above its tip. The inner malleolus, which presses against the astragalus, may be partially broken off by the latter at the same time.

The mechanism is reversed in eversion and abduction of the foot. The internal lateral ligament is here put on the stretch on the inner side of the ankle joint, and is either ruptured in case of great violence, or it holds and the inner malleolus is torn off. In addition to this, the

tip of the external malleolus is crushed, or the fibula is fractured five or six centimetres above the tip of the malleolus. This latter fracture is a very common one.

Adduction and abduction alone, without inversion or eversion, also give rise to fractures of the malleoli either by avulsion or crushing of the same. Violent adduction (inward rotation) of the foot either causes a sprain in the mid-tarsal joint and rupture of the anterior fasciculus of the external lateral ligament, or fracture of the external malleolus, in consequence of pressure against the posterior edge of the astragalus, or a torsion fracture of both bones of the leg. Violent abduction (outward rotation) either causes a rupture of the tibio-fibular ligaments, or, if these hold, a triangular fragment of bone is usually torn from the outer lower end of the tibia, answering to the insertion of the anterior tibio-fibular ligament. The fibula breaks at the typical place, five or six centimetres



FIG. 876.—Pott's fracture: 1, fracture of the fibula; 2, the outer lower edge of the tibia; and 3, the internal malleolus.

above the tip, in consequence of pressure against the outer surface of the astragalus. Finally, the internal malleolus also may be torn away by the internal lateral ligament. An incomplete outward dislocation is sometimes combined therewith, in that the tibia is displaced inward with the upper fragment of the fibula, and the foot is displaced outward with the lower fragment of the fibula and the part of the tibia that is broken off (Fig. 876).*

* This combination of fracture of the tibia and fibula, with outward displacement of the foot, is known in this country as Pott's fracture.—TR.

in consequence of rupture of the tibio-fibular ligaments, so that there is, as it were, an upward dislocation of the foot. Fracture of the fibula at the typical place, five or six centimetres above the malleolus, may occur in this way without fracture of the outer border of the tibia.

Compound fractures and dislocations not infrequently result from the action of great violence, so that the tibia or the astragalus perforates the skin.

The symptoms of fractures of the malleoli are particularly distinct when there is a displacement of the fragments. There is usually some eversion of the foot in fractures of the fibula at the typical place five or six centimetres above the tip of the malleolus, the more so if the fragments override. A thorough examination should be made in all cases of suspected fracture, and the lower end of the fibula and the tibia carefully palpated. If the periosteum is also torn, the usual symptoms of fracture

(abnormal mobility and crepitus) are easily made out. If there is a marked extravasation of blood, it is removed as far as possible by gentle massage. When other symptoms of a fracture are absent, the localized tenderness is also of great diagnostic importance. Sprains and fractures are not infrequently confused. In doubtful cases one should, in the beginning at least, treat the injury as a fracture, until the swelling has disappeared and a more exact diagnosis is possible. In dislocations the free movements of the ankle joint are disturbed, and the relation of the malleoli to the tarsal bones is changed.

The ankle joint with its ligaments suffers damage in all malleolar fractures, either in the form of a complete or incomplete dislocation, or only a strain or sprain.

The prognosis of fractures of the malleoli depends very largely, aside from the extent of the injury to the bones and the soft parts, upon a correct diagnosis and a proper treatment. If a mistake is made in these directions a permanent deformity may result only too easily, with impaired mobility of the ankle joint. The most frequent, in fact the typical, deformity is much the same as that attending flat foot—that is, the foot is displaced outward, and the longitudinal axis of the leg does not strike the middle of the sole of the foot, but its inner border (Fig. 877). Compound fractures are, of course, to be treated under strictly aseptic methods, in order to prevent suppuration of the ankle joint. Pseudarthrosis sometimes results.

Separation of the lower epiphysis is described on pages 815 and 819.

The treatment of fractures of the malleoli is as follows: In all cases in which there is marked swelling the extremity should be placed,



FIG. 877.—Union of a Pott's fracture with deformity.

first of all, with the ankle joint at right angles in a Volkmann splint, Chamer's wire splint, or Petit's box splint, etc. It should be somewhat elevated, the extravasation of blood removed by gentle massage, and a plaster-of-Paris splint applied as soon as permissible. In all cases where the swelling is mild the plaster-of-Paris splint should be applied at once. The ankle must be at a right angle and the inner border of the great toe must be in a line with the inner border of the patella. The plaster-of-Paris splint is to be changed every eight or ten days, in order that the fracture may be inspected and stiffness of the ankle avoided by gentle massage and passive motion. It is a good plan, in treating fractures of the fibula at the typical place, five or six centimetres above the lower extremity, to put up the foot in a plaster splint in a position of inversion.

In order to prevent subsequent limitation of movement in the ankle joint it is a good plan to change the position of the foot at frequent intervals—i. e., it may be inverted, placed at right angles, flexed, or extended. This should be particularly the case in compound fractures.

In case of extensive comminution of the lower end of the tibia and the fibula, splints similar to those used in fractures of the leg and the thigh may be used in place of the circular plaster-of-Paris splint (see page 732, Figs. 816 and 817). The splint may be removed after three weeks even in favourable cases of simple fracture, and massage and active and passive movements begun soon afterward. In other cases five or six weeks are required for the union of the fracture. Walking is always permissible earlier, of course, after fracture of the fibula than after that of the tibia.

In case of malunion (see Fig. 877) one will, if necessary, perform osteotomy and correct the deformity.

§ 353. **Sprains of the Ankle.**—We have already mentioned, on page 835, that sprains of the ankle and the astragalo-tarsal joints have practically the same etiology as fractures and dislocations of the malleoli, with the simple difference that we have to do here with the action of less violence. Sprains are caused by eversion or inversion of the foot, which result in nothing more than a stretching or partial rupture of the lateral ligaments in particular, with a corresponding extravasation of blood. Sprains are to be regarded as momentary, incomplete dislocations, as it were, whose reduction takes place at the very moment of their occurrence. The extravasation of blood is sometimes very marked, so that the distinction between a fracture and a simple sprain may be difficult for the inexperienced. One must in such cases obtain a complete history of the accident from the patient, and carefully palpate the lower end of the tibia and fibula, with the patient under an

anæsthetic, it may be, after removing the extravasation of blood by gentle massage.

Sprains of the ankle joint were formerly treated, very improperly, by keeping the foot at rest, and even by plaster splints. Permanent functional disability, stiffness of the joint, etc., were a frequent consequence of this incorrect treatment. The best results are secured by the immediate employment of massage in fresh sprains. Exercise in walking, active and passive movement of the ankle joint, baths, and liniments, are also to be recommended. When the amount of extravasated blood is excessive, an elevated position for a few days and the use of ice, together with gentle massage, are serviceable. In doubtful cases, when one can not be sure whether there is a fracture or not, one should treat the injury as such for a few days, until the extravasation of blood is diminished and a sure diagnosis is possible.

§ 354. **Dislocations of the Foot.**—Dislocations of the bones forming the ankle joint proper occur but rarely, and only from the action of great violence. The incomplete dislocations are the most frequent. Dislocations of the foot constitute, according to Krönlein, scarcely one half of one per cent of all dislocations. We distinguish, according to the frequency of their occurrence, outward, backward, and forward dislocations, and finally, as the rarest of all, dislocations upward between the tibia and fibula. For congenital dislocations of the foot, see page 873.

I. **Lateral Dislocations of the Foot.**—These dislocations are always combined with fracture of the malleoli. They arise from the action of the same violence as malleolar fractures—that is, from eversion and inversion, or abduction and adduction of the foot. We saw that these movements are executed, not in the ankle joint, but in the astragalotarsal joint, chiefly in its posterior portion (see page 834). These lateral dislocations of the ankle are, therefore, more correctly to be regarded as primarily fractures of the malleoli, with secondary displacement of the foot and the fragments.

1. *Outward Dislocation of the Foot* (Figs. 878, 879).—This is the most common dislocation, and arises from violent eversion and from abduction—e. g., from “turning the foot,” or from falling over to one side with the foot firmly held. There follows, in the first place, a fracture of the fibula at the typical place, five or six centimetres above its lower extremity, from pressure of the outer surface of the astragalus (Fig. 878, 2). The internal lateral ligament on the inner side of the ankle joint is put on the stretch, and is either ruptured or it tears off the inner malleolus (Fig. 878, 1). In consequence of the continued action of the violence, or in consequence of the weight of the body,

the foot is still further everted, and finally dislocated either completely or incompletely. In the incomplete outward dislocation (Fig. 879) the

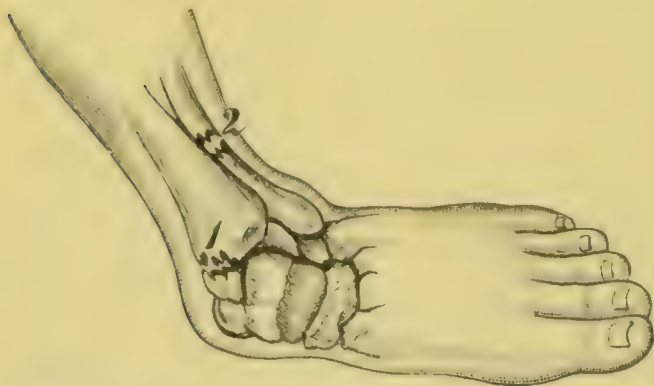


FIG. 878.—Dislocation of the foot outward with fracture of the internal malleolus (1) and the fibula (2).



FIG. 879.—Incomplete dislocation of the foot outward (Anger).

tibia remains partially in contact with the articular surface of the astragalus. In the very rare complete outward dislocation of the foot

(Fig. 878) the tibia has entirely left the articular surface of the astragalus, the upper articular surface of the latter is directed inward, and the foot is abducted and everted. The joint is much broadened and the leg is shortened. The astragalus can be felt beneath the internal malleolus in all outward dislocations if the extravasation of blood is not too great. The decided eversion of the foot, as in fracture of the fibula at the typical place, is characteristic of all outward dislocations. The astragalus projecting under the inner malleolus can easily perforate the skin. In rare cases the dislocated foot is not everted, as in Fig. 878, but is simply abducted. These rare dislocations of the foot arise from its violent abduction—that is, it describes a quarter of a circumference outward about a

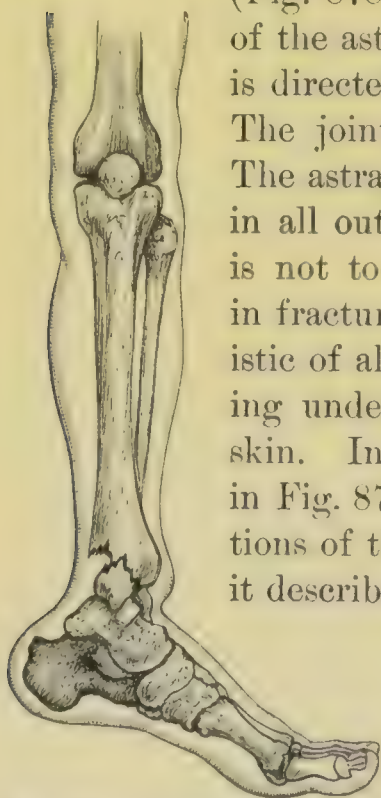


FIG. 880.—Dislocation of the foot by outward rotation with fracture of the internal malleolus.

vertical axis. The toes are directed outward, the inner border forward, the outer border backward, and the astragalus is held firmly in the tibio-fibular mortise (Fig. 880).

2. *Inward Dislocation of the Foot* (Fig. 881).—This dislocation is much rarer than that outward. It arises from violent inver-

sion and adduction. As marked violence has usually been exerted, the soft parts are generally severely injured, and for this reason these inward dislocations belong to the most dangerous of all dislocations at the ankle. The lower end of the fibula may easily perforate the skin. Here also the inner malleolus is usually broken by the pressure of

the astragalus, and the fibula is fractured at the typical place (Fig. 881). The foot is in marked inversion, the superior articular surface of the astragalus is directed outward, while the inferior articular surface is rotated inward with the foot. In incomplete inward dislocation of the foot (Fig. 881) the inner border of the superior articular surface of the astragalus presses against the tibia. In the very rare complete dislocations the tibia may slip outward over the articular surface of the astragalus, as the inner malleolus is usually broken off. The astragalus is not infrequently fractured. In inward dislocations of the foot also there may be simple adduction without inversion—that is, the reverse of that represented in Fig. 880.

The diagnosis of lateral dislocations of the ankle is usually easy, except when there is a very marked extravasation of blood. The prognosis is most unfavourable in cases of compound dislocation that have not been treated under aseptic methods. Due attention is always to be paid to the coexisting fractures of the malleoli.

The reduction of lateral dislocations of the foot is usually easy, but the permanent retention of the bones is sometimes difficult. Reduction is accomplished by traction on the foot, pressing it inward or outward, and rotating it in a direction opposite to the existing deformity—that is, in dislocation inward the foot is abducted and everted, and in dislocation outward adducted and inverted. The knee joint and the hip joint are to be flexed in order that the muscles may be relaxed. Should the retention of the bones in their normal position be attended with difficulty, Pick and other English surgeons recommend tenotomy of the tendo Achillis. Fractures of the malleoli are treated according to the rules given on pages 837, 838. For the treatment of compound fractures and dislocations the reader is referred to *Principles of Surgery*, pages 597, 717, and 726; see also page 844.

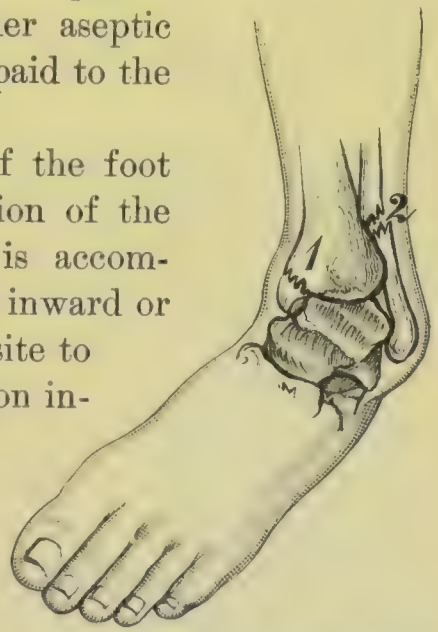


FIG. 881.—Incomplete dislocation of the foot inward with fracture of the internal malleolus (1) and the fibula (2).

II. Forward Dislocation of the Foot (Fig. 882).—These dislocations, whether complete or incomplete, are by no means so frequent as lateral dislocations. In case of complete forward dislocation, the tibia and fibula are no longer in contact with the articular surface of the astragalus, but lie in front of the tendo Achillis upon the posterior upper surface of the os calcis. In incomplete dislocations, which are the more common, the anterior border of the articular surface of the tibia rests

upon the posterior portion of the articular surface of the astragalus. The dislocation arises from violent dorsal flexion of the foot. The bones of the leg, especially the tibia, slip backward and rupture the



FIG. 882. — Dislocation of the foot forward with fracture of the internal malleolus (diagrammatic).

tensely stretched posterior portion of the capsule. The lower end of the tibia sometimes perforates the skin above the heel. Fractures may be completely absent, but here also the internal malleolus particularly (Hönigsmied), less often the external malleolus, may break off. The tendo Achillis is usually not ruptured.

The deformity attending forward dislocation of the foot is very characteristic (Fig. 882, *a* and *b*), especially when the dislocation is complete. The foot is strikingly elongated, the projection of the heel is more or less obliterated, and the lower end of the tibia and the fibula can be felt in front of the tensely stretched tendo Achillis, while the trochlea of the astragalus is to be felt in front of the tibia. The foot is held fixed in its abnormal position, sometimes in slight dorsal flexion, and sometimes in plantar flexion, when it sinks downward in consequence of its own weight. The dislocation can easily be distinguished from the similar deformity attending transverse fractures of the bones of the leg or of the tibia above the malleolus, especially in consequence of the abnormal relation of the malleoli to the tarsal bones.

The symptoms are essentially the same in incomplete forward dislocations as in the complete, but they are not so distinct, and it is often hard to say, especially when there is decided swelling, whether the case is one of dislocation or transverse fracture, or separation of the lower epiphysis of the tibia.

The prognosis of a simple forward dislocation of the foot is not unfavourable. In case of compound dislocation or of fracture of the astragalus and the malleoli, or of extensive injury to the soft parts, the

ankle joint remains, as a rule, more or less stiff. A loose joint, on the contrary, is sometimes observed.

The reduction of a forward dislocation of the foot is most easily effected, as a rule, by strong dorsal flexion and direct pressure upon the lower end of the tibia from behind, while at the same time the foot is pressed backward and downward. Hueter accomplished reduction in this way after a dislocation had lasted for six months. Reduction is sometimes difficult, however, and in such cases tenotomy of the tendo Achillis is to be recommended. The after-treatment consists in immobilization of the ankle at right angles for two or three weeks by means of a plaster-of-Paris splint, and then in massage and passive and active movements. If there are any fractures they are treated in accordance with the rules applicable to them (see fractures of the malleoli, of the astragalus, and of the tibia). Compound dislocations are treated under aseptic methods, with drainage of the joint and resection, it may be, of the bones that interfere with reduction (see also page 844, and Principles of Surgery, page 719).

III. **Backward Dislocations of the Foot** (Fig. 883 *a*, after Anger, and 883 *b*). This dislocation is more frequently incomplete than complete. In case of the latter, the articular surface of the astragalus lies wholly



FIG. 883.—Dislocation of the foot backward with fracture of the fibula (diagrammatic).

behind that of the tibia, and in the incomplete form the posterior border of the tibia rests upon the highest point of the trochlea of the astragalus. Dislocation backward is somewhat more frequent than that forward. It arises most commonly from violent plantar flexion, by which the lower end of the tibia slips forward over the trochlea and ruptures the anterior portion of the tensely stretched capsule of the joint. The malleoli are often broken off and slip backward with the foot, or remain connected with the bones of the leg.

The very characteristic symptoms of backward dislocation of the

foot are the reverse of those attending dislocation forward. The foot is strikingly shortened, and the heel is elongated and very prominent. The sharp edge of the tibia can be felt in front upon the dorsum of the foot, and the tendo Achillis forms a concave arch behind above the heel and can be grasped with the fingers. The trochlea of the astragalus can be easily palpated in front of the tendo Achillis. The toes are more or less flexed by tension of the flexor muscles, and the anterior portion of the foot is usually in slight plantar flexion. Dorsal and plantar flexion of the foot are very much restricted. The symptoms are not so pronounced in cases of incomplete dislocation, or when there is a large extravasation of blood. In doubtful cases a thorough examination should be made, with the patient under an anæsthetic. As regards the prognosis, the same is true as in forward dislocations of the foot.

Reduction is accomplished by extreme plantar flexion, traction on the foot in a forward direction, and direct pressure backward, against the lower end of the tibia. Finally, the foot is brought into dorsal flexion. The after-treatment is the same as that for dislocation forward. For the treatment of compound dislocations see page 845, and *Principles of Surgery*, page 719.

IV. Dislocation Upward between the Tibia and Fibula, which are forced apart, is not included among dislocations by most authors, but is regarded as a result of fracture of the leg in its lower third. Experienced observers, however, like Fergusson, Morris, Bryant, and others, affirm that this dislocation also occurs without fracture. The injury arises usually from a fall upon the soles of the feet from a considerable height. The trochlea of the astragalus can be displaced upward thereby between the fractured or (less often) unfractured bones of the leg after the ligaments between the tibia and the fibula and those between the latter two and the tarsus have been ruptured. The malleolar region is then strikingly broadened and approximated to the sole of the foot. The astragalus is nowhere to be felt, in consequence of its incarceration between the tibia and fibula.

The deformity is overcome by traction upon the foot with the patient under an anæsthetic. In Bryant's case, where the dislocation was double, reduction was impossible, and the patient had subsequently ankylosis of the ankle joint. If reduction proves impossible, an attempt should be made to remove the existing obstacles by aseptic arthrotomy. For the treatment of fractures of the leg see page 816.

The following brief statement should be added regarding the treatment of compound dislocations of the ankle: It is difficult to lay down rules for their treatment that are generally applicable. Each case has

to be considered by itself. The treatment depends very largely upon the amount of injury to the soft parts, and upon the condition of the patient in other respects (age or constitution). In case the injury to the soft parts is severe, and suppuration of the ankle joint and gangrene already exist, amputation is indicated. In milder cases, when the external wounds are slight and the joint has not become infected, reduction under antiseptic precautions may be successful without drainage of the joint. Generally speaking, however, drainage of the ankle joint and resection, it may be, followed by a strictly antiseptic after-treatment, will be found necessary (see also Principles of Surgery, page 719).

The patient is instructed to wear a firmly laced boot with lateral splints for a time after recovery from the dislocation.

§ 355. **Dislocations of the Ankle at the Astragalo-tarsal Joint (Subastragaloid Dislocations).**—In this very rare dislocation the astragalus is displaced from the calcaneum and scaphoid, but remains in the tibio-

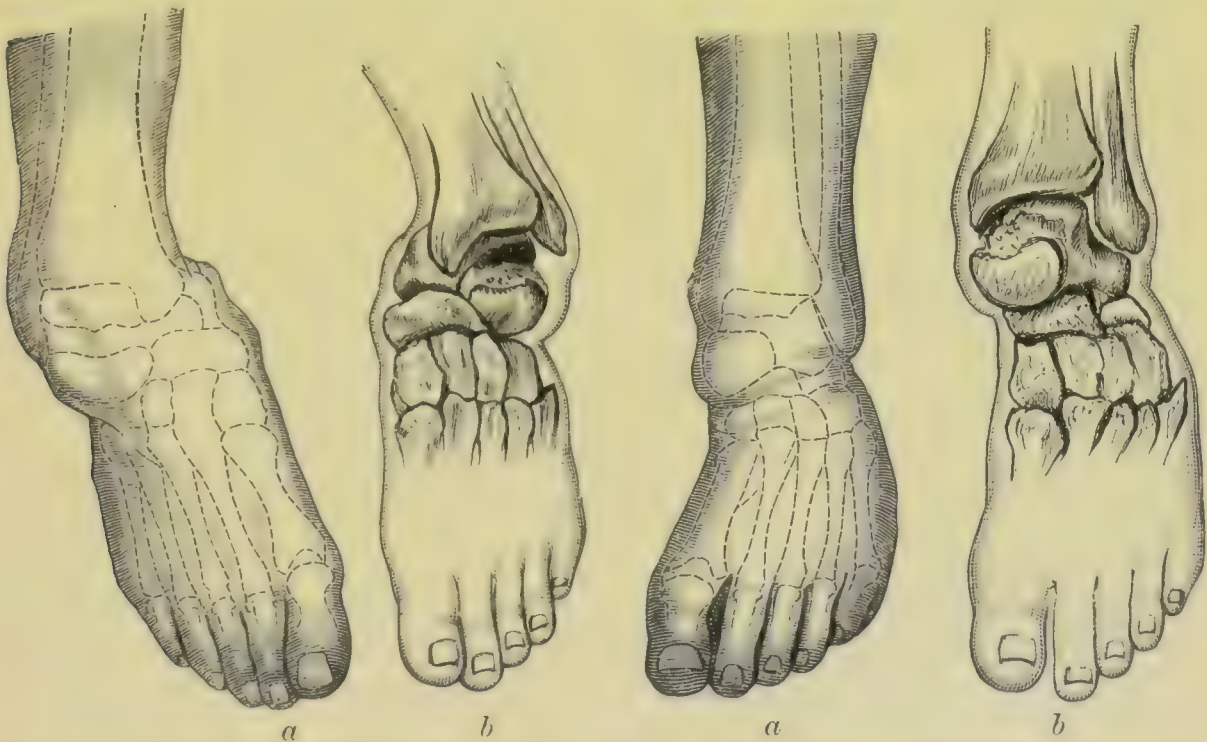


FIG. 884.—Inward subastragaloid dislocation.

FIG. 885.—Outward subastragaloid dislocation.

fibular mortise. Subastragaloid dislocation was first described in detail by Broca. We are under special obligation to Henke for a recent thorough investigation of this variety of dislocation. It takes the form of an inward, outward, forward, or backward dislocation, and is caused usually by violent inversion, eversion, abduction, or adduction.

1. *Dislocations Inward* (Fig. 884 *a*, after Anger, and 884 *b*).—This dislocation arises from forcible inversion and adduction. A fulcrum is

formed by the pressure of the lower edge of the astragalus against the sustentaculum tali of the os calcis and the entire foot, with the exception of the astragalus which remains in normal contact with the bones of the leg, is displaced inward more or less completely, with rupture of the capsule and ligaments joining the astragalus with the os calcis and the scaphoid.

The symptoms consist in inversion of the foot and a marked prominence of the tuberosity of the scaphoid on the inner side of the foot, so that the inner malleolus can scarcely be felt, while the edge of the os calcis or the sustentaculum tali can be felt distinctly. The external malleolus is prominent on the outer side of the ankle joint. In front of and to the inner side of it the head of the astragalus can be felt through the skin. The neck of the astragalus is sometimes fractured. Active movements of the foot are impossible, and passive motion is very much restricted.

2. *Dislocations Outward* (Fig. 885 *a*, after Anger, and 885 *b*).—This form of dislocation is the most frequent, having been observed thirteen times, according to Hoffa, among twenty cases of subastragaloid dislocation. It arises from forcible eversion and abduction of the foot, whereby the anterior lower edge of the astragalus presses against the opposite outer and upper surface of the anterior process of the os calcis. The joint between the astragalus and the os calcis gapes and the astragalus is forced inward with the tibia and the fibula, and the remainder of the foot is dislocated outward, with rupture of the ligaments and the capsule between the astragalus and the scaphoid. There is sometimes a fracture of the external malleolus (MacCormac). The head of the astragalus lies to the inner side of the scaphoid and usually upon it. The lower articular surface of the astragalus rests upon the sustentaculum tali.

The symptoms of this dislocation are the reverse of those attending dislocation inward—that is, eversion of the foot. On the outer side of the foot it is noticed that the external malleolus is depressed, and the outer side of the os calcis and the cuboid are very prominent. The latter is true of the internal malleolus and the head of the astragalus on the inner side of the foot. The tuberosity of the scaphoid lies in front of and somewhat outward from the head of the astragalus. The inner surface of the os calcis, which is displaced outward and covered by the astragalus, is scarcely to be felt.

3. *Dislocations Forward* (Fig. 886).—This very rare dislocation arises from dorsal flexion of the foot, which, however, is much more likely to cause a forward dislocation of the whole foot. The origin of forward subastragaloid dislocations is as follows: The fulcrum is at the

anterior border of the calcaneo-astragaloid joint, and at this point the anterior border of the body of the astragalus presses against the corresponding edge of the articular surface of the os calcis, and while the astragalus is held firmly in its mortise the tibia and fibula slide backward with the astragalus.

The symptoms are similar to those attending forward dislocation of the whole foot, the only difference being that the astragalo-scaphoid articulation gapes (Fig. 886), and the head of the astragalus, which lies

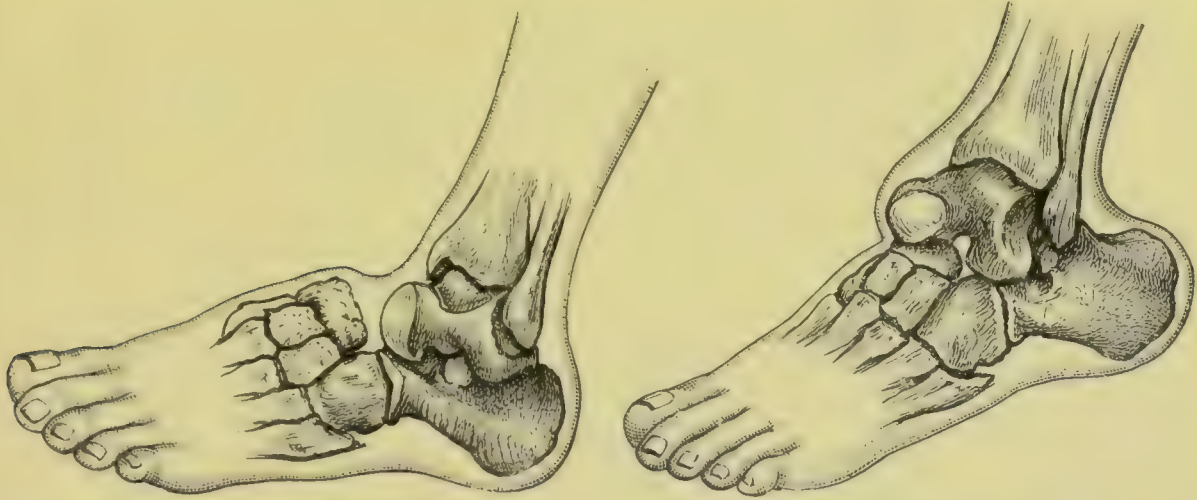


FIG. 886.—Forward subastragaloid dislocation. FIG. 887.—Backward subastragaloid dislocation.

free, and the articular surface of the scaphoid can be felt in front below the tibia and fibula. Moreover, the position of the malleoli with reference to the lateral surfaces of the astragalus is normal, but their relation with the remaining tarsal bones is disturbed. Fractures of the astragalus and os calcis sometimes occur.

4. *Dislocations Backward* (Fig. 887).—This dislocation also, which arises from forcible plantar flexion of the foot, is very rare, because dislocation of the whole foot is much more likely to result. It arises from pressure of the posterior border of the astragalus against the posterior edge of the articular surface of the os calcis, whereupon the astragalus slides forward with the tibia and fibula. The head of the astragalus lies upon the scaphoid (Fig. 887), or still farther forward in the region of the cuneiform bones, and can easily perforate the skin. In other respects the symptoms are similar to those attending backward dislocation of the whole foot (see Fig. 883, page 843), except that here the malleoli are displaced forward with the astragalus, and have changed their position with reference to the remaining tarsal bones. Fractures of the astragalus and os calcis and of the external malleolus are the most common. In very exceptional cases the scaphoid remains connected with the dislocated astragalus, and loses its connection with the three cuneiform bones (Burnett, C. Kaufmann).

The diagnosis of the different forms of subastragaloid dislocation may be made difficult by marked swelling of the soft parts. In all such cases an examination should be made with the patient under an anæsthetic and the extravasation of blood removed by massage. The various subastragaloid dislocations resemble the analogous dislocations of the whole foot. The two malleoli, however, retain their normal relation with the astragalus, and the mobility of the ankle joint (dorsal and plantar flexion) is not impaired, while inversion, eversion, and adduction and abduction of the foot are restricted—that is, those movements which take place in the astragalo-tarsal joint. Finally, the abnormal position of the astragalus with reference to the tarsal bones can usually be easily determined by careful palpation of the tarsus, especially when the patient is under an anæsthetic.

The prognosis of subastragaloid dislocation is, generally speaking, favourable if it is not compound and if the injury is properly recognised and treated. The use of the foot is impaired, of course, for a time. If, in consequence of a wrong diagnosis, the dislocation is not reduced, the functional disability is very great, so that it may be necessary to excise the astragalus or resect its head.

The Treatment of Subastragaloid Dislocations.—The knee and the hip are to be flexed at right angles in reducing all dislocations, in order that the muscles of the leg may be relaxed as much as possible.

In outward dislocations reduction is accomplished by abduction and eversion and then extension, with direct pressure upon the astragalus from the inside and upon the foot from the outside. The reduction is completed by adduction.

Inward dislocations are reduced by adduction and inversion, with extension and direct pressure upon the astragalus from the outside and against the foot from the inside, and finally abduction.

In forward dislocations reduction is accomplished by increased dorsal flexion, traction, and direct pressure backward.

Dislocations backward are reduced by increased plantar flexion, traction, and direct pressure, especially upon the astragalus, from in front backward.

The foot is immobilized at right angles for two or three weeks after reduction by means of a plaster-of-Paris or a Volkmann splint, and use is then made of massage and active and passive movements. The patient should wear a firmly laced boot at first with lateral splints.

If reduction is not successful with the patient under an anæsthetic, division of the tendo Achillis is sometimes of advantage, and it may be necessary to remove the obstacle by operation—e. g., by resection of the head of the astragalus or excision of the astragalus. These operations have also been performed with good results in cases of compound dislocation. The skin sometimes becomes gangrenous, secondarily, in consequence of the swelling or of pressure of the astragalus. Healing

is hastened after demarcation of the gangrene by aseptic excision of the gangrenous portions of tissue.

Dislocations in the mid-tarsal joint are extremely rare. The astragalus and the os calcis remain in their normal position, and the scaphoid and the cuboid with the remaining portion of the foot are to be regarded as the dislocated part, which may be displaced upon the dorsum or toward the sole of the foot or laterally. The doubt regarding the occurrence of this dislocation is unjustified, as is shown also by an observation of Bose and Fuhr. The treatment is essentially the same as that of subastragaloid dislocations.

§ 356. **Isolated Dislocation of the Astragalus and of the other Bones of the Tarsus.**—The isolated complete or incomplete dislocation of the astragalus from its articulations with the tibia and fibula, the os calcis, and the scaphoid is rare, but is the most common of the isolated dislocations of the tarsal bones (Fig. 888). The literature of the subject contains, according to Malgaigne, Iversen, Hoffa, and others, about ninety cases. The astragalus is, as it were, the keystone of the arch of the foot and the bone which is principally concerned in the movements of the ankle as well as those of the astragalo-tarsal joint. Of the isolated dislocations of the astragalus, dislocations forward, or forward and outward, are the most common; while dislocations backward, or backward and outward, or backward and inward, are the most rare. In exceptional cases the astragalus is rotated about its sagittal or vertical axis, so that the trochlea is directed downward or to one side.

Isolated dislocations of the astragalus arise from forcible and irregular movements in the astragalo-tibial and astragalo-tarsal joints. According to the experiments made by Henke, the astragalus is first separated from its connection with the tibia and fibula by violent plantar or dorsal flexion, and from its articulation with the os calcis and the scaphoid by eversion or inversion and abduction or adduction of the foot. Forward dislocation of the astragalus arises, according to Henke, from forcible dorsal flexion with eversion or inversion of the foot, and backward dislocation from plantar flexion with eversion or inversion. Stetter, on the contrary, adopts, upon the ground of two observations, a reversed order of movements in the occurrence of isolated dislocations of the astragalus, and it is, in his opinion, an open question whether a dislocation of the astragalus forward or backward results from dorsal or from plantar flexion. It is, at all events, a fact that forward dislocations of the astragalus have arisen from dorsal as well

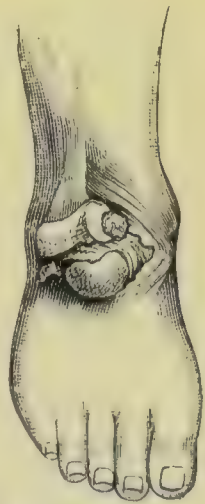


FIG. 888.—Forward dislocation of the astragalus.

as plantar flexion, as is proved, for example, by the observations of Löbker, Riedinger, and G. Middeldorpf.

The dislocated astragalus sometimes rotates about its vertical or sagittal axis, as was mentioned above. Its rotation about the sagittal axis arises, no doubt, from the fact that the tibia, at the moment the dislocation of the astragalus occurs, presses sometimes against the inner and sometimes against the outer edge of the astragalus (Stetter). Hoffa emphasizes the resistance which the dislocated bone meets with in the elastic tendons and stretched soft parts on the opposite side. Dislocation of the astragalus is sometimes complicated by a wound in the skin, through which the astragalus (as, for example, in the two cases of Malgaigne and Norris) may be forced out and found lying upon the ground. The dislocation may be combined with fracture of the astragalus. When the neck of the astragalus is fractured its head may remain in its normal place, while its body is dislocated (F. Küster, Dumont).

The symptoms of isolated dislocation of the astragalus are characterized, above all, by the abnormal position of the bone in this place or that (forward, backward, outward, or inward displacement). The dislocated bone, with its well-characterized form, can usually be felt easily under the tensely stretched skin, or it lies exposed in the wound. The foot is inverted or everted, according to the nature of the dislocation, and is movable neither actively nor passively. It can scarcely be determined in the living subject, as soon as a large swelling has appeared, whether or not rotation of the dislocated astragalus has taken place.

The prognosis of every dislocation of the astragalus is doubtful, especially that of a dislocation complicated by a wound of the skin or a fracture. The sooner after the injury reduction is successfully accomplished, the more favourable is the prognosis. In one case observed by Stetter, normal function of the foot was secured after reduction of the astragalus, so that the patient was able to undertake long mountain tramps without any discomfort. Such favourable results are exceptional in cases of complete dislocation of the astragalus. Reduction is very often impossible, so that it is necessary to remove the bone. Suppuration of the articulations of the foot was frequently observed after compound dislocations of the astragalus before the adoption of antiseptic methods. Gangrene of the skin and of the tendons or necrosis of the astragalus itself may also occur.

Treatment of Dislocation of the Astragalus.—Reduction is to be attempted as soon as possible after the injury, in the following manner, by increasing the inversion or eversion and by extension and direct pressure: The knee and hip being flexed (for the relaxation of the muscles), the leg is grasped above the malleoli, the deformity still

further increased, and powerful traction then exerted upon the foot, and the astragalus finally reduced by direct pressure. In some cases the bone springs back into its normal place with a snapping sound. The astragalus should be replaced even though it may be almost completely separated from all its connections. There is no great danger of necrosis, as it does not receive its blood supply from below alone, but from other directions as well.

The after-treatment consists in immobilizing the foot at right angles for about three weeks by means of a plaster splint. The patient should make his first attempts at walking in a jointed water-glass splint (see Principles of Surgery, page 223) or in a laced boot with a splint, and massage, baths, and active and passive movements are employed. The function of the foot may become almost normal again.

If reduction does not succeed in this way, with the patient under an anæsthetic, either the open reduction of the dislocated astragalus, after cutting down upon the same, is to be recommended (Bergmann), or early aseptic excision of the astragalus, before the condition of the patient is made worse by further complications (swelling, gangrene, suppuration). In compound dislocations the wound should be disinfected, the bone reduced, and the wound drained. If reduction is unsuccessful, or if suppuration already exists, or necrosis of the dislocated astragalus is threatened, its excision is indicated. In case of extensive suppuration of the tarsus, with danger of death from sepsis or pyæmia, amputation of the leg is to be performed.

Isolated dislocations of the remaining tarsal bones are very rare and, generally speaking, of but little surgical interest. Dislocations of the os calcis, the scaphoid, the cuboid, and the three cuneiform bones have been observed occasionally, as the result of great violence.

Lossen mentions two cases of isolated dislocation of the os calcis which were observed by Dumas. Both were outward dislocations, arising, in one case, from the falling of the body to one side while the foot was fixed, and in the other case from the falling of a beam upon the inner side of the foot. In both instances the outer and upper surface of the os calcis could be felt below the external malleolus, which had sunk deeply into the soft parts. Reduction was effected by traction upon the leg in an outward direction and by pressure inward upon the os calcis.

Lossen mentions six cases of dislocation of the scaphoid, which is likewise very rare. They were dislocations inward and upon the dorsum of the foot. The scaphoid is sometimes dislocated with the astragalus in subastragaloid dislocations. The inner border of the foot is shortened in dislocation of the scaphoid, and the tuberosity of the latter is not to be felt in its normal place. The best means of reduction is by plantar flexion, abduction, and direct pressure upon the dislocated bone.

Finally, the following additional dislocations of the tarsal bones have been observed : Dislocation of the first cuneiform bone and of the three cunei-

form bones together, from a fall upon the tip of the foot or from being run over. Dislocation of the first cuneiform bone in an upward and inward direction has been observed. Lossen mentions three cases of dislocation of the three cuneiform bones upon the scaphoid. The reduction of these dislocations is accomplished by downward pressure upon the front part of the foot and by direct pressure upon the dislocated bone. If reduction is not successful, the dislocated bone should be promptly removed.

§ 357. **Dislocations of the Metatarsal Bones and of the Toes.**—The metatarsal bones may either be dislocated altogether or singly. Hitzig and Hoffa collected, in all, forty cases.

Dislocation of all the metatarsal bones in the tarso-metatarsal joint (Lisfranc's joint) may occur in an upward, downward, outward, or inward direction. Dislocation upward is the most frequent, and arises from violence inflicted upon the tarsus from above, so that the heads of the metatarsal bones are displaced upon the dorsum of the foot. The symptoms are very characteristic. The dorsum of the foot is more arched than normal, and the projecting heads of the metatarsal bones can be distinctly felt. The toes are in dorsal flexion.

Dislocation of all the metatarsal bones downward is much more rare. Lossen mentions a case observed by Smyly resulting from forcible dorsal flexion. The heads of the metatarsal bones project in the sole in this dislocation, the foot is shortened, and there is a deep furrow upon the dorsum of the foot in front of the cuneiform bones and the cuboid.

Inward or outward dislocations of all the metatarsal bones are impossible without fracture of the second metatarsal bone, which is held firmly between the first and third cuneiform bones. Lateral dislocation sometimes occurs secondarily, however, without fracture, from an upward dislocation. Only one instance is known of an inward dislocation of all the metatarsal bones. An outward dislocation was observed by Lacombe, Schrauth, Sandwith, Langier, and others.

The prognosis of other than compound dislocations of all the metatarsal bones at the tarso-metatarsal joint is favourable. Reduction is best effected by strong traction on the metatarsal bones while the tarsus is held firmly, and then by direct pressure with both thumbs upon the dislocated bones.

Dislocations of single metatarsal bones at the tarso-metatarsal joint are much more rare. They originate in the same way as the dislocations of all the metatarsal bones, except that here only one metatarsal bone is affected by the action of the violence. Reduction is accomplished here also by traction and direct pressure. If reduction is impossible, the tarso-metatarsal joint in question is exposed, and then the obstacle removed or the bone resected.

Dislocations of the toes at the metatarso-phalangeal joint are confined almost wholly to those of the great toe, which may be dislocated either upward or inward.

Dislocation of the great toe upon the dorsal surface of the metatarsus arises from violent dorsal flexion of the toe, whereby the head of the metatarsal bone is pressed so strongly against the lower part of the capsule that the latter is ruptured. The metatarsal bone is dislocated downward—that is, the first phalanx of the great toe is displaced toward the dorsum (Fig. 889).

The dislocation is sometimes complete and sometimes incomplete. The symptoms are very distinct, especially when the dislocation is complete. The head of the metatarsal bone can be distinctly felt in the sole of the foot, and the base of the first phalanx is found upon the dorsum of the metatarsal bone. The active movements of the great toe are suspended. The skin on the sole of the foot is not infrequently perforated by the head of the metatarsal bone. This occurred ten times, according to Malgaigne, among nineteen cases.

The reduction of dorsal dislocations of the great toe is best accomplished by increasing the existing dorsal flexion and then pushing the phalanx forward with the fingers over the metatarsal bone, whereupon it is brought into place by traction, extension, and plantar flexion.

Similar difficulties may occur here as in the reduction of dislocations of the thumb, and they should be overcome in the same way. The sesamoid bones or the tendon of the flexor longus hallucis may become interposed and prevent reduction. In case of irreducible and compound dislocations, resection of the head of the metatarsal bone is to be recommended. In a compound dislocation, attended with severe injury of the soft parts, disarticulation may be indicated.

Inward dislocation of the great toe at the metatarso-phalangeal joint arises usually from forcible abduction, particularly when the toe is in a position of right-angled dorsal flexion (Bartholmai). Lossen quotes only two cases observed by Malgaigne and Notta. Reduction was easily effected by traction upon the toe and direct pressure upon the end of the phalanx. Reduction by abduction and pressure upon the articular surface of the first phalanx is better.

Dislocations of the phalanges are very rare. Riedinger, who had a case of upward dislocation of the second phalanx of the middle toe of the right foot, states that there are but three cases in literature of dislocation of the phalanges. Dislocation upward results not only from simple hyperextension, but also from abduction with subsequent extension and adduction. These movements produce the dislocation experimentally upon the cadaver (Riedinger).

Reduction is performed by pushing forward the phalanx, which is in dorsal flexion. Inward dislocation of the last phalanx of the great toe, with perforation of the skin, has been observed (Pinel). Its reduction is accomplished by extension and direct pressure.

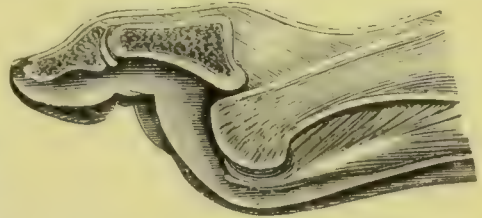


FIG. 889.—Dorsal dislocation of the great toe.

§ 358. **Fractures of the Bones of the Foot.**—In view of the frequency of injuries of the foot, fractures of its bones are rare, because the violence used is weakened by their mobility.

1. **Fractures of the Astragalus.**—We have already mentioned that fractures of the astragalus sometimes occur in connection with dislocations of this bone. Complete or incomplete fractures of the astragalus without its dislocation are very rare. They occur occasionally,

in consequence of a fall from a considerable height, from being run over, from twisting the foot, etc. The direction of the line of fracture varies greatly, and may be horizontal, transverse, antero-posterior, or T-shaped. Gaupp has collected from literature fifty-nine cases of fracture of the astragalus.

The transverse fractures of the astragalus are the most common. In comminuted fractures other tarsal bones are usually injured—e. g., the os calcis—or there are fractures of the bones of the leg. The symptoms of a fracture of the astragalus depend upon whether the fragments are displaced or not. When the fragments are displaced, the fracture may be mistaken for a dislocation of the astragalus. If there is no displacement, the diagnosis is difficult, and most of the cases are taken for severe sprains. Crepitus can sometimes be made out by movements of pronation or supination, or by dorsal and plantar flexion. The fact that the patient is unable to stand and complains of deep-seated pain, particularly when the foot is moved at the ankle or at the astragalo-tarsal joint, is also important for the diagnosis. There is almost always considerable swelling in the region of the astragalus. The prognosis is much the same as that of dislocation of the astragalus, and is most favourable in simple fractures where there is no displacement. Complete restoration to the normal is possible after a fracture of the astragalus, but there results in some cases partial or complete ankylosis of the ankle. Necrosis of the fragment of the astragalus that has been broken off has also been observed. Compound fractures that are not treated under aseptic methods may endanger the life of the patient, in consequence of suppuration of the ankle joint, sepsis, and pyæmia.

Simple fractures without displacement are treated by immobilization of the ankle joint at right angles for three or four weeks by means of a plaster-of-Paris splint. When there is marked swelling the leg should be placed for a few days upon a Volkmann splint and kept elevated. If there is displacement, reduction of the fragment that has been broken off should be attempted. If reduction is not successful, one may accomplish it by means of an operation, or may remove the broken-off fragment or the entire astragalus. Removal of the astragalus is indicated particularly in compound comminuted fractures. For the antiseptic treatment of compound fractures see also pages 858, 859, and Principles of Surgery, page 597 ff.

2. Fractures of the Os Calcis.—Fractures of the os calcis are also rare, but are easier to diagnose than those of the astragalus. The greatest variety of fractures of the os calcis has been observed, especially transverse fractures, oblique fractures, longitudinal fractures, and commi-

nated fractures (Fig. 890). The fractures in the posterior part of the bone are the most common. The most frequent and the more or less typical fractures are those of the tuberosity of the os calcis, caused by forcible contraction of the tendo Achillis—e. g., from a fall or a jump upon the feet or from a misstep; also the fractures by compression, resulting, for example, from a fall from a considerable height, whereby the os calcis is crushed by the astragalus either longitudinally or, more frequently, into several fragments (Fig. 890). Fractures by compression may be bilateral. In comminuted fractures the fragments may be more or less impacted. In case of transverse fractures of the tuberosity of the os calcis, the fragment of bone that is broken off is displaced more or less in an upward direc-



FIG. 890.—Comminuted fracture of the os calcis (Anger).

tion with the tendo Achillis, and can therefore easily be felt here. The fractures by compression and other fractures of the os calcis are characterized by marked swelling in the region of the heel, by pain, and it may be by crepitus, over the tuberosity of the os calcis and in the sole of the foot. It is usually impossible for the patient to stand on his feet. The foot is flattened, and the malleoli are approximated to the sole of the foot. The prognosis of fractures due to a forcible contraction of the tendo Achillis is more favourable than that of fractures by compression. The latter usually unite slowly, requiring, according to Gurlt, sixty days on the average. Flat foot almost always results, and the gait is, not infrequently, permanently unsteady. Pseudarthrosis is to be feared in connection with fractures of the tuberosity if the treatment is not of the proper kind.

Treatment of Fractures of the Os Calcis.—In case of fracture of the posterior tuberosity of the os calcis, a plaster-of-Paris splint is applied after reduction of the displaced fragment of bone, with the knee sharply flexed and the foot in plantar flexion, in order that the muscles of the calf may be relaxed as completely as possible. Should it be difficult to retain the fragment of bone that is broken off in its normal place, one may perform tenotomy of the tendo Achillis, or simply nail or suture the fragments together. Union requires thirty to forty days.

In case of fractures by compression or simple comminuted fractures one should at the outset, if there is much swelling, place the extremity upon a Volkmann splint with the foot in plantar flexion,

or suspend it by means of a dorsal splint (Fig. 891, page 859). After eight or ten days a plaster splint is applied. Compound fractures of the os calcis are treated according to general rules and with antiseptic precautions (see page 858, and *Principles of Surgery*, page 597 ff.).

Among other fractures of the os calcis, that of the sustentaculum tali and of the outer tubercle of the os calcis should be mentioned.

The sustentaculum tali serves, as is well known, as a support for the astragalus, and the tendon of the flexor hallucis muscle runs in a groove on its plantar surface. According to Abel, who saw three cases of isolated fracture of the sustentaculum tali, the fracture arises from forcible inversion with adduction. The foot is in a valgus position, and the heel is shortened in consequence of a slight forward displacement of the os calcis. There is localized tenderness on the anterior inner surface of the foot in the region of the sustentaculum tali. The use of the foot for walking or standing is more or less impaired. If the fragment of bone is completely broken off, it is usually displaced somewhat downward. Bony union follows promptly, as a rule, but the valgus position of the foot and the restriction of inversion and eversion, and also of abduction and adduction, may be permanent.

The treatment consists in the application of a closely fitting plaster-of-Paris splint to the ankle and lower part of the leg after the fragment of bone, which may be displaced downward, has been restored to its normal position.

The external tubercle of the os calcis lies below the external malleolus, is the point of insertion of the middle fasciculus of the external lateral ligament, and beneath it runs the peroneus longus muscle. Fracture of this process was observed by Bidder, among others, from traction of the middle fasciculus of the external lateral ligament. The symptoms of the fracture consist in an extravasation of blood and the presence of a broken-off and movable fragment of bone below the tip of the external malleolus. The patient experiences great pain in bearing his weight upon the foot. Bony union with normal ability to walk can usually be secured by means of a closely fitting plaster-of-Paris splint applied with the ankle joint at right angles.

3. Fractures of the Remaining Tarsal Bones.—Fractures of the scaphoid, the cuboid, and the cuneiform bones almost always result from the action of direct violence, especially from compression, with or without a wound of the soft parts, or from a gunshot injury. The course even of compound fractures is favourable if the injury comes at once under antiseptic treatment (see *Principles of Surgery*, pages 597–602). Suppuration of the joints of the foot and of the tendon sheaths is especially to be guarded against. In case of extensive comminution of the tarsal bones, one should seek to preserve as much of the foot as possible, and should resort to amputation only when the soft parts are severely injured. (See *Operations on the Foot*, § 369,

page 901 ff., and § 370, page 905 ff. For gunshot wounds, see also § 359.)

4. Fractures of the Metatarsal Bones and the Toes.—Fractures of the metatarsal bones arise chiefly from direct violence (the falling of a heavy body upon the foot, being run over, etc.), and they are therefore usually combined with injury to the skin. Indirect fractures of the metatarsal bones have been observed in rare cases, resulting from a fall upon the front part of the foot. If only one metatarsal bone is broken, a displacement of the fragment is prevented, as a rule, by the neighbouring metatarsal bones that are intact. If several metatarsal bones are broken, the fragments are usually displaced toward the sole or the dorsum of the foot. The diagnosis of a fracture of the metatarsal bones may be difficult if there is much swelling.

The treatment of these fractures, which are usually compound, conforms to general rules and should be strictly antiseptic. The displacement is overcome, the wound is disinfected and drained, and the extremity is placed upon a Volkmann splint. The rare simple fractures are treated by the application of a plaster-of-Paris splint or the use of a Volkmann splint.

Fractures of the toes also are usually attended with injury to the covering of soft parts. The diagnosis is easily made. Parts of the toes are sometimes completely torn away, as is the case with the fingers, so that the bone projects from the wound. In such cases enough of the projecting bone should be removed with bone-cutting forceps, under local anæsthesia, to enable the end of the bone to be covered with soft parts. The best way is to amputate the stump of bone at the next joint. Healing is most speedily accomplished also in cases of crushing of the toes by amputation of the involved phalanges. Simple fractures of the toes are best immobilized by suitable splints—e. g., of gutta-percha—and the neighbouring toes are used as splints, as is done with the fingers.

§ 359. **Wounds of the Joints of the Foot.**—We have already mentioned wounds of the joints of the foot in describing fractures and dislocations. Wounds of the joints of the foot also arise occasionally from punctures and incised wounds, and, above all, from gunshot injuries. For the course and the treatment of wounds of joints and gunshot wounds the reader is referred to § 123, page 726 ff., and § 124, page 731 ff., of Principles of Surgery. Only the following brief statement need be added here:

Gunshot wounds of the ankle joint are almost always combined with injury of the tibia and the fibula, the astragalus, and, it may be, the remaining tarsal bones. Gunshot wounds without injury to the bone

are possible only in the anterior part of the ankle joint, when, for example, only the skin and the capsule have been grazed.

If wounds of the joint run an aseptic course, their prognosis is favourable. Otherwise, extensive suppuration easily ensues in the ankle and the tarsal joints. The mortality of gunshot wounds of the tarsus was formerly very high, but it is less at present, from the fact that we can prevent suppuration, sepsis, and pyæmia by aseptic treatment of the wound.

Treatment of Wounds of the Joints of the Foot.—Fresh cases of simple punctured or incised wounds of a joint, without any demonstrable infection, are carefully disinfected, covered with iodoform gauze, and immobilized by the use of an antiseptic protective dressing and a Volkmann splint. This aseptic treatment often succeeds in preserving a movable joint. If the temperature rises, the patient complains of pain, and suppuration of the joint is threatened, the joint should be freely opened, disinfected with 1-to-1,000 bichloride, drained, and immobilized upon a Volkmann splint. A movable joint may here also result. If symptoms of severe inflammation appear, in spite of disinfection and drainage, or if extensive suppuration already exists, resection of the joint should be performed; or if sepsis is threatened, amputation is indicated.

The treatment of wounds of the joints of the foot that are combined with injury of the bone—e. g., gunshot wounds—is as follows: The strictest aseptic methods are to be employed as well as a conservative treatment, both in practice in peace and in military practice. Primary amputation is indicated only in cases of very severe injury of the bones and the soft parts—e. g., from a cannon shot. In practice in peace one should not carry the expectant method of treatment too far in treating injuries of the bones of the foot, but should proceed here according to the rules applicable to the treatment of compound fractures (see *Principles of Surgery*, pages 597–602). In military practice, however, an expectant antiseptic treatment of gunshot wounds is to be recommended at the outset, with disinfection of the wound, drainage (packing), and an antiseptic protective dressing, with the foot immobilized at right angles upon a Volkmann splint or by suspension—e. g., as represented in Figs. 891 and 892—or by means of a splint of plaster of Paris and hemp, etc. In other respects the treatment of gunshot wounds is to be carried out according to general rules (arrest of the hæmorrhage, removal of foreign bodies, such as the ball, shreds of clothing, etc.). Too zealous and long-continued search for the ball is objectionable. It often heals in the tissues without reaction, and can, if necessary, be extracted later. If the superficial wound is small, aseptic healing

beneath the scab sometimes takes place. In case of severe injury to the soft parts, antiseptic irrigation is to be recommended. If the bones are extensively comminuted, the splinters are removed and primary

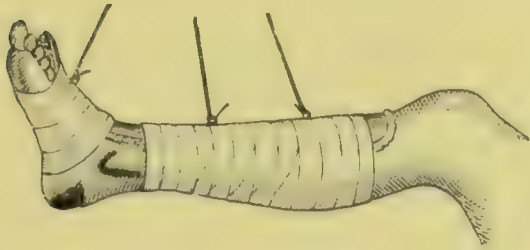


FIG. 891.—Suspension of the ankle by means of an anterior splint (Volkmann).

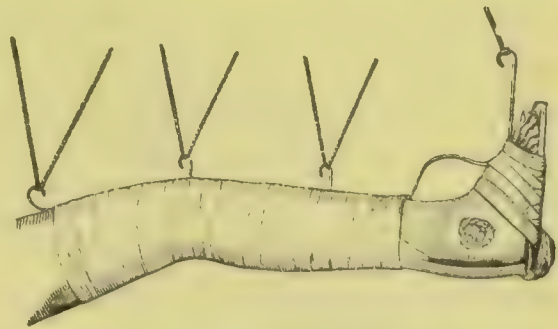


FIG. 892.—Suspension of the lower extremity by means of a wooden splint and telegraph wire (Esmarch).

resection—e. g., of the ankle—is performed if necessary. If the astragalus is shattered, it is excised by means of a longitudinal incision on the anterior aspect of the ankle joint, along the inner border of the extensor tendon of the second toe, reaching to the astragalo-scaphoid articulation. As a general rule, as much of the foot is preserved as possible. Amputation is indicated only in cases of severe comminution of the bone or crushing of the soft parts, or when sepsis and pyæmia are threatened. For the technique of the different operations upon the foot, see §§ 368–370, pages 895–905 ff. For injuries of the vessels and nerves, see pages 809–812.

Strict care is to be taken, in treating all injuries of the ankle, that the joint heals in a right-angled position, and that, above all, pes equinus does not result, which interferes later with walking and standing. If ankylosis of the ankle joint ensues, the patient may still walk very well and even take long tramps, if the foot is only in a favourable (right-angled) position, without inversion or eversion.

Among other injuries of the soft parts of the foot, we have already mentioned injuries of the vessels and the nerves on pages 809–812. The treatment of other wounds, of injury to the tendons, etc., is the same as on the hand and the fingers (see page 602). The contusions of the soft parts of the toes, with an extravasation of blood beneath the nail—e. g., of the great toe—which are so common, heal most quickly by removal of the nail, followed by an aseptic after-treatment as described on pages 871, 872. Laceration of the plantar fascia sometimes occurs in fractures and is of considerable practical importance (Ledderhose). It gives rise later to painful nodular swellings and indurations, which usually disappear, however, spontaneously. The diseased places are to be relieved from pressure by some arrangement inside the shoe. The nodules may, if necessary, be excised.

§ 360. **Diseases of the Ankle and the Bones and Joints of the Foot.**—The different forms of acute synovitis are observed in the ankle joint—viz., the acute serous, sero-fibrinous, and suppurative. Acute serous synovitis arises, for example, from simple fractures in the region of the ankle, from sprains, from acute articular rheumatism, etc. Acute suppurative synovitis develops after compound fractures of the joints and dislocations that are not treated aseptically, after incised, punctured, and gunshot wounds of the joint, and also, secondarily, from suppuration in the vicinity of the joint—e. g., suppurative tenosynovitis or acute osteomyelitis.

Tubercular inflammations are the most common of the chronic inflammations of the ankle. They begin most frequently in the bone, particularly in the astragalus or the tibia, less frequently in the fibula and in the synovial membrane. In case the disease begins primarily in the astragalus, the inflammation may break through into the ankle and the astragalo-tarsal joints. In this way extensive caries of the tarsal bones may result. Caries of the tarsal bones arises in other cases from tubercular periostitis and osteomyelitis of other tarsal bones, or from primary tubercular disease of the tarsal joints, the surrounding soft parts, especially the tendon sheaths, etc.

Among other forms of inflammation of the ankle are gonorrhœal arthritis (see Principles of Surgery, page 662), arthritis deformans, particularly after fracture of a joint (see Principles of Surgery, page 683), and, finally, tabetic (neuropathic) arthritis, which we likewise described in Principles of Surgery, page 693, with special reference to the ankle.

For the symptomatology and the diagnosis of the different forms of inflammation the reader is referred to the more detailed description in Principles of Surgery. An effusion within the ankle is first noticeable anteriorly alongside the extensor tendons—that is, the normal depressions that exist here are more or less obliterated and the portion of the joint in the region of the malleoli has a characteristic fulness. Fluctuation is felt on both sides of the extensor tendons, especially when the ankle is in moderate dorsal flexion. Later, as the effusion increases in amount, there is a corresponding swelling beneath the malleoli, and beside and under the tendo Achillis. The more pronounced the inflammatory swelling of the skin and of the periarticular soft parts, and the more pain there is, combined with fever, the more certain is it that the fluid in the joint is purulent. The nature of the intra-articular exudation may, if necessary, be determined by means of an exploratory needle.

Tubercular inflammation also of the ankle joint, especially the more

rare primary synovial form, is first demonstrable in front in the form of an effusion, or a soft, doughy swelling on both sides of the extensor tendons. If there is a primary focus in the astragalus, in the tibia, or in the fibula, or there is primary disease of the tendon sheath, the ankle joint is at first intact and the diseased bone is enlarged and painful, or the tubercular disease is confined to the tendon sheaths, while the ankle joint is movable and painless. In case of primary synovial disease with effusion, the joint may likewise be intact. In cases of primary disease of the bone, excellent results are secured by scraping out the focus in the bone early, before the ankle joint becomes diseased. As soon as the tubercular process has broken through into the ankle joint, active and passive dorsal flexion and plantar flexion of the joint become more and more restricted and painful. If the astragalo-tarsal joints are likewise diseased—e. g., in tuberculosis of the astragalus—inversion and eversion of the foot also, as well as abduction and adduction, are then restricted and painful. Fever does not always attend tuberculosis of joints, and it may be absent even after periarticular abscesses have formed. In other cases high fever is observed from time to time, or more continuously—e. g., after traumatisms and movements of the joint.

From a therapeutic standpoint it is of great importance to determine, in cases of tuberculosis of the ankle, whether the ankle joint alone is diseased or other articulations of the tarsus have already been attacked, especially the two astragalo-tarsal joints. If eversion and inversion with abduction and adduction are still normal, the joints last named are not yet diseased. It is also important, in judging of the extent of the disease, to determine whether this or that bone is enlarged and painful. The entire foot is often more or less swollen, and there are numerous fistulæ. In such cases an operation first determines, often, to what extent the foot is diseased.

Tuberculosis of the ankle joint may be cured at any stage. Its course is more favourable in children than in adults. Extensive carious destruction of the joint may be cured in children, with or without an operation, with a tolerable preservation of the function of the joint. The prognosis of tuberculosis of the ankle joint has become more favourable of late among adults also, in consequence of treatment with iodoform and thorough scraping or arthrectomy (synovectomy).

Treatment of Inflammations of the Ankle Joint.—For the treatment of acute and chronic serous, sero-fibrinous, and suppurative synovitis, acute articular rheumatism, arthritis deformans, tabetic disease, gonorrhœal arthritis, etc., the reader is referred to Principles of Surgery, pages 666–696, and to the same diseases of the knee joint, page 782 ff. Puncture

and incision of the ankle are best performed on both sides of the extensor tendons. Counter-openings for drainage should be made posteriorly between the fibula and the tendo Achillis.

The treatment of tuberculosis of the ankle conforms to the same principles as that of tuberculosis of the knee (see page 785, and Principles of Surgery, page 679 ff.). At the outset, and even later, when fistulæ already exist, I recommend, above all, in addition to immobilization and elevation of the joint, injections of ten-per-cent iodoform-glycerin or iodoform oil, two to ten grammes, according to the age of the patient, at intervals of from two to four weeks. I have secured very surprising results by this treatment, and am convinced that iodoform is really an antitubercular remedy. The injections are best made in the anterior region of the joint, on both sides of the extensor tendons. The joint should be moved in different directions after the injections, so as to distribute the iodoform throughout the joint. Tubercular tenosynovitis and tubercular foci in the tibia and the fibula and in the tarsus must be subjected to treatment before they involve the ankle joint. The further treatment of tuberculosis is symptomatic. It consists in immobilization of the joint for a time by means of a plaster-of-Paris splint in cases without fistulæ, in opening periarticular abscesses, in scraping out the joint when there is caries, etc. Complete resections are to be avoided in children, but they are of course permissible in adults, in case of extensive disease. For the incisions to be made in opening the ankle joint for arthrectomy (synovectomy), the reader is referred to § 368, page 895 ff. If the astragalus is extensively diseased, it is excised (see page 864). As a general rule, one should be as conservative as regards the preservation of bone in dealing with the ankle joint as with other joints. The conservative treatment of tubercular disease of the ankle often requires great patience, and years may go by before a cure is effected. In the worst cases, when there is extensive disease of the ankle joint and the tarsus, with possibly nephritis, phthisis, or amyloid degeneration, amputation of the leg is the best treatment, if Pirogoff's or Syme's operation is no longer possible. Osteoplastic resection, after Mikulicz-Wladimirow, is a useful operation in the treatment of some cases of extensive disease of the ankle joint and the tarsus. The constitutional treatment of the patient, by means of good nourishment, fresh air, residence in elevated health resorts or in a warm climate, and the use of brine baths, sea baths, etc., is of great importance in dealing with all cases of joint tuberculosis.

In the further course of all inflammations of the ankle joint care must always be taken that the joint is kept in a right-angled position

so as to secure a good use of the foot later, even if ankylosis ensues. *Pes equinus* (plantar flexion), which so easily results, must be especially guarded against, as the foot tends to assume this position from its own weight.

Inflammations of the Joints of the Tarsus.—The articulations that come particularly into consideration here are the two astragalo-tarsal joints and the following five separate joints, viz.: 1. The articulation between the cuboid and the os calcis. 2. That between the three cuneiform bones and the scaphoid. 3. That between the first cuneiform bone and the metatarsal bone of the great toe. 4. That between the second and third cuneiform bones and the second and third metatarsal bones. 5. That between the cuboid and the fourth and fifth metatarsal bones.

Acute inflammations of the two astragalo-tarsal joints are observed especially after open wounds. The joints are fairly well protected against incised and punctured wounds, but are more liable to gunshot wounds. The ankle joint is then usually injured as well, and the bones are more or less shattered. The escape of the pus is difficult in suppurative inflammations of these joints, and hence high fever and severe local manifestations are often observed.

The suppuration frequently passes over to the tendon sheaths, particularly the sheath of the *tibialis posticus*, and from here spreads up the leg or breaks through into this or that tarsal joint. It is then often difficult to say in case of marked swelling which of the joints are involved. A thorough examination should be made in order to determine, above all, whether the function of the ankle joint (dorsal and plantar flexion) and that of the astragalo-tarsal joints (eversion and inversion, with abduction and adduction) are restricted and painful.

The chronic inflammations of the two astragalo-tarsal joints are almost exclusively of tubercular origin. They occur most frequently after tubercular osteomyelitis of the bones that form the joints, usually of the astragalus, less often of the os calcis and the scaphoid. Primary tuberculosis of the synovial membrane is rare. The tuberculosis may spread from the astragalo-tarsal joints and involve the other tarsal bones and joints, so that extensive carious destruction of the tarsus finally ensues.

In other cases the order is reversed, the astragalo-tarsal joints being affected secondarily after the neighbouring tarsal bones and joints have been attacked by tuberculosis. It is of great practical importance, moreover, that the tubercular foci sometimes break through externally without occasioning disease of the neighbouring joints. Foci in the posterior portion of the os calcis, for example, are most favourable in this respect. It is more common, to be sure, for a focus in one of the tarsal bones to involve a neighbouring joint. Acute osteomyelitis is observed in rare cases in the tarsus—e. g., in the os calcis, with necrosis of the same.

The treatment of acute and chronic inflammations of the astragalo-tarsal joints and the remaining tarsal joints is practically the same as that of similar inflammations of the ankle. In case of acute suppuration a free exit is given for the pus, either by an incision or, it may be, by resection of the joints.

In tubercular disease of the astragalo-tarsal joints the latter should be thoroughly scraped out, and, if necessary, the astragalus or the os calcis resected or extirpated. It is not a good plan to scrape out the os calcis. The cavities are slow in healing, and it is therefore better to resect the part of the bone that is diseased.

Excision of the Astragalus.—The astragalus is removed most easily by means of a longitudinal incision over the ankle joint along the outer border of the extensor tendons of the toes, extending to a point in front of the astragalo-scaphoid joint. After division of the skin, fascia, and anterior annular ligament, the tendons of the extensor longus digitorum are lifted from the subjacent parts and drawn inward. The extensor brevis digitorum is then incised and retracted outward. The external malleolar artery and vein are cut between two ligatures. The ankle joint is then opened, its capsule and ligaments detached with the knife, and the periosteal elevator and the neck and the head of the astragalus exposed. A transverse incision is then made at the middle of the anterior longitudinal incision to a point beneath the tip of the external malleolus. The peronei muscles remain intact. The soft parts are divided by layers down to the astragalus, and the external lateral ligament is severed close to the malleolus. After division of the interosseous ligament between the os calcis and the astragalus (with the chisel if necessary), the astragalus is removed with the foot inverted, the connections that still remain being cut close to the bone.

Resection or Excision of the Os Calcis is accomplished either by means of Ollier's external angular incision or by means of the posterior curved incision of Ried and Erichsen. The latter incision encircles the lower surface of the os calcis in the form of a horseshoe. Ollier's incision begins two centimetres above the tip of the external malleolus on the outer border of the tendo Achillis, runs downward to the lower border of the os calcis, passes forward at right angles along the lower and outer border of the os calcis, and ends near the base of the fifth metatarsal bone. The soft parts are then separated from the os calcis, subperiosteally if possible, in the course of the incisions named, without opening the tendon sheaths. The articulation with the cuboid is severed first, then the upper connection with the astragalus and the sustentaculum tali, etc. The bone is then removed and the wound sutured or packed. Partial resections follow the same general lines.

Tubercular disease of a tarsal bone is treated by scraping it out with a sharp spoon, or, still better, by removing the bone in question. Conservatism should here also be the rule. As was urged in connection with tuberculosis of the ankle joint, so here also one should pre-

serve as much as possible, especially in treating young patients. Amputation has become more and more restricted. Kappeler and others have secured very favourable results with extensive atypical resections of the foot in cases in which amputation was formerly resorted to (see page 905). These results appeal strongly for the adoption of this course. For the technique of resection of the tarsus and the extirpation of separate bones, see page 901.

Inflammatory Processes in the Bones and Joints of the Metatarsus.—Acute osteomyelitis is sometimes observed in the metatarsal bones, with partial or complete necrosis of the diseased bone. After the inflammation has had its course, or after separation of the sequestrum, the latter is extracted.

Chronic inflammations are more frequent, especially the tubercular inflammations of the metatarsal bones, which are either confined to the latter or are combined with disease of the tarsus and the ankle. The tubercular process either begins in the metatarsal bones, giving rise to the characteristic bottle-shaped inflation of the bone which is seen also on the fingers (see page 663, Fig. 753), or the disease appears first in the neighbouring joints and passes over from these to the bone. It behaves in precisely the same way on the phalanges. If a tarso-metatarsal joint is diseased, there is great danger that the tuberculosis will involve the tarsus. It is a matter of practical importance that a cleft between the first and second cuneiform bones leads from the tarso-metatarsal joint to the scaphoid, and this bone is hence particularly endangered. Furthermore, it is to be remembered that the scaphoid is in contact with the astragalus, and the latter can extend the infection to the ankle and the astragalo-calcaneal joints. Large abscesses are sometimes formed, especially in the sole of the foot.

The treatment of tuberculosis of the bones and joints of the metatarsus is precisely the same as that of tubercular disease of the bones and joints of the tarsus. A thorough operative treatment should be entered upon promptly so as to prevent the spread of the disease to the tarsus (scraping, extirpation of the involved metatarsal bone, the involved phalanx of the toe, etc.). The function of the foot is usually impaired by the complete removal of the metatarsal bone of the great toe. In case of subperiosteal removal the regeneration of the metatarsal bones is usually incomplete. If several of them are affected, partial amputation of the foot by Lisfranc's or Chopart's method is indicated (see pages 907–910). These operations should be performed, however, only in extreme cases. Conservative surgery is here also the rule.

Metatarsalgia.—More or less severe pain in the region of the metatarsus, especially in the heads of the metatarsal bones, sometimes occurs in those individuals who wear narrow shoes after they have walked for some distance. This "metatarsal neuralgia," which has been described particularly by Morton, Bradford, and others, is almost always localized in the head of the fourth metatarsal bone. It seems to be caused mainly, as has been said, by wearing narrow shoes—that is, by lateral pressure of the head of the fifth metatarsal bone against the adjacent nerve. The pain is sometimes occasioned by tonic contraction of the muscles or by subluxation of the heads of the metatarsal bones with pressure upon the nerves. The head of the fourth meta-

tarsal bone in particular may be displaced beneath the third (Pollosson). If the neuralgia can not be overcome by wearing broader shoes, by abducting the fifth toe, etc., a cure is quickly effected by resection of the head and a part of the shaft of the fourth metatarsal bone. Metatarsalgia is sometimes conditioned upon gout, and is then to be treated accordingly.

It remains to speak of diseases of the bones and joints of the toes. Tubercular disease of the toes has much the same course as that of the fingers and the metatarsus, but it is by no means so frequent as the latter. The treatment is the same in both (see page 664). For the technique of resection and disarticulation of the toes the reader is referred to §§ 369 and 370, pages 901-905 ff.

Acute inflammations of a very severe character and of a septic nature sometimes occur in the joints of the toes after punctured wounds, and also secondarily from suppurative tenosynovitis and phlegmonous processes. Gout (arthritis urica) is the most common acute inflammation of the joints of the toes.

Gout (Arthritis Urica) is most frequently localized in the metatarso-phalangeal joint of the great toe among individuals in the higher walks of life. The uric-acid diathesis or gout is to be regarded as essentially a disturbance of nutrition. Hand in hand with an increase in the amount of nitrogenous food taken into the system there is an increase in the amount of nitrogen secreted. The percentage of uric acid and urates is increased in the blood and they are deposited in the form of fine crystals, especially in the cartilage and in the capsule of the metatarso-phalangeal joint of the great toe and its vicinity, because this joint is predisposed among elderly persons to venous engorgement in consequence of walking and standing. The crystalline deposits in and around the joint consist of urate of soda and of combinations of uric acid with lime, magnesia, ammonia, and hippuric acid. This form of arthritis is characterized by a more or less pronounced phlegmonous inflammation and swelling of the joint named and its vicinity. The inflammatory symptoms gradually increase, as a rule, for some days and then as gradually abate. The pain is usually very severe. The attacks of gout occur especially in the spring, and they often increase in number and intensity with advancing years. Any of the joints in the upper and lower extremities may be attacked by the inflammation, including the large joints, such as the ankle, knee, wrist, etc. Joints that are frequently attacked by gout finally show changes similar to those attending arthritis deformans. Nodular deposits of uric acid, the so-called tophi, which have a chalky character, form in the surroundings of the joints, in the tendon sheaths, and in the subcutaneous tissue, as well as abscesses which perforate the skin and discharge a tenacious, creamy, or more granular yellowish material consisting of uric-acid salts. Persons with gout often reach an advanced age. Severe cases, however, are not infrequently observed which are char-

acterized by disease of the larger joints and which have an early fatal termination in consequence of nephritis, endocarditis, and arterio-sclerosis. The severer forms of gout are more frequent in England than in Germany, but they seem, generally speaking, to run a more favourable course there.

The treatment of gout is directed partly against the existing disturbance of nutrition (uric-acid diathesis) and partly against the local process. Almost every sufferer from gout has his own approved method of treatment. The local treatment is of use mainly in diminishing the pain. It consists particularly in elevating the foot, smearing the joint with fat or vaseline, and enveloping it in dry cotton or wet compresses. Cold, in the form of ice or liquor plumbi subacetatis with ice, is often not endured, while in other cases it does excellent service. Hypodermic injections of morphine are frequently not to be dispensed with. Lithia and salicylate of soda are given internally. Diaphoretic remedies have the reputation of shortening the attack. A light (reduced) diet is important, and as a drink Rhine wine with seltzer water or something of the kind is permissible. In the chronic stages of gout Hueter recommends highly the injection of carbolic acid into the joint or its vicinity. Abscesses and fistulæ are most quickly cured by incision, and, if necessary, scraping out or resecting the joint that is affected.

A temperate mode of life, especially as regards the use of alcohol, is above all to be recommended as a means of mitigating or overcoming the disposition to attacks of gout and the uric-acid diathesis. The free use of meat is to be avoided and more of a vegetable diet is preferable. The waters at Carlsbad, Kissingen, Marienbad, Vichy, and those of other saline springs are helpful, as well as a sojourn at the hot springs of Gastein, Töplitz, Wiesbaden, etc.

§ 361. **Inflammatory Processes in the Soft Parts of the Foot.**—The different forms of gangrene are here especially important.

Senile Gangrene.—Senile gangrene is conditioned upon atheromatous degeneration of the small arteries, or, in other words, chronic obliterative endarteritis. In consequence of the latter the normal nutrition of the toes suffers and venous stasis or inflammatory œdema easily ensues, sometimes after slight traumatisms and often without these. Senile gangrene is more common in men than in women, and seldom appears before the seventieth year. The disease most frequently begins in the great toe, with discoloration of the skin and with a sensation of cold and numbness. The symptoms of dry or moist gangrene then appear. In dry gangrene (Fig. 893) a black, dry eschar is formed and the dead portion of the skin becomes mummified.

The gangrene is either limited to a larger or smaller area—e. g., the great toe—or it spreads with greater or less rapidity. A line of demarcation (Fig. 893) is formed at the boundary of the gangrene, and at this point there are always secretion and putrefaction—that is, the moist form of gan-

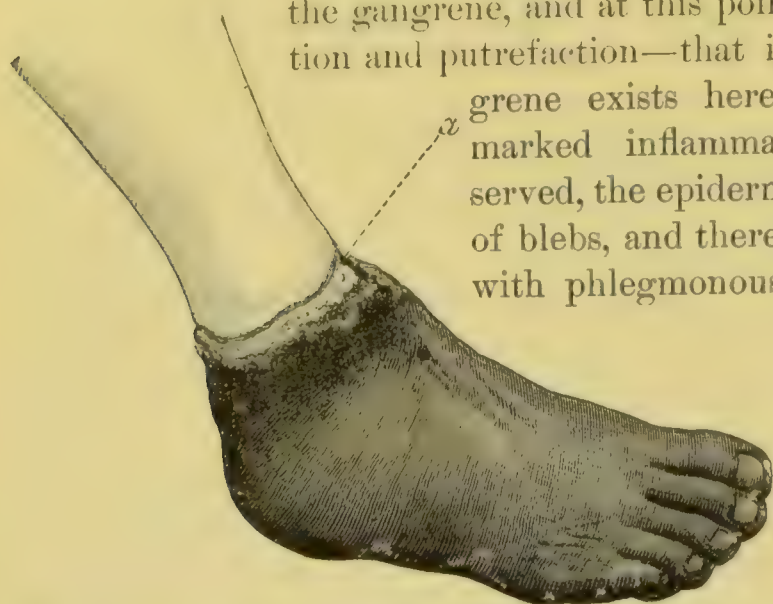


FIG. 893.—Dry gangrene of the right foot: *a*, line of demarcation.

grene exists here. In other cases more marked inflammatory symptoms are observed, the epidermis is elevated in the form of blebs, and there is an abundant secretion, with phlegmonous symptoms and fever, so that the life of the patient is endangered. The pain is usually very severe in dry as well as in moist gangrene. There is high fever, particularly in moist gangrene, in consequence of the absorp-

tion of the products of putrefaction. The course of senile gangrene varies greatly in individual cases. The gangrene often remains localized for a long time, and healing takes place after the eschar falls off. Recurrences occur, however, very easily. In other cases the gangrene spreads rapidly, so that prompt amputation of the foot or the leg, or, after the gangrene has spread to the leg, amputation of the thigh becomes necessary to save the patient from death from general sepsis.

Diabetes is sometimes complicated by gangrene of the toes even in young and apparently perfectly healthy individuals. In case of gangrene, therefore, the urine should always be examined for sugar. The walls of the vessels and the tissue cells have so little resistance, owing to the abnormal composition of the blood, that even insignificant traumas or infections give rise to inflammatory disturbances of the circulation, with stasis and gangrene. Caution should therefore be used in operating upon patients suffering from diabetes. Diabetic gangrene is due essentially to a pronounced arterio-sclerosis of the vessels, which is usually present, even among younger persons, with thrombosis of the same, as in senile gangrene (Israel, König, E. Küster, L. Heidenhain, the author).

For the gangrene that follows burns and frostbites the reader is referred to *Principles of Surgery*, page 485 ff., and page 495 ff.

Gangrene of the Toes and the Foot in Ergotism.—This form of gangrene, which was most common in the middle ages and resulted from eating bread

contaminated with the ergot fungus, occurs particularly among individuals who are poorly nourished. Ergotism is characterized by disturbances of digestion, general weakness, tingling sensations, and a feeling of numbness and pain in the extremities. Gangrene then appears on the toes, the ears, the nose, etc., and spreads rapidly. Ergot gangrene is to be referred primarily, according to Zweifel, to the anæsthesia produced by the ergotin, so that those affected can not sufficiently protect themselves from the action of traumatisms in consequence of lack of sensation in the skin. In addition to this, the individual is badly nourished and the small arteries are in a condition of contraction, as a result of the ergotin, causing local anæmia.

Nervous disturbances also favour the development of gangrene, as we have already suggested in speaking of ergot gangrene. This explains the gangrene occurring in the course of leprosy (see Principles of Surgery, § 85, page 439) and in paralyzed portions of the body, whether it be that the function of the trophic nerves is disturbed or that necrosis of the tissue and ulceration arise because paralyzed persons do not feel pain and therefore can not avoid external injurious influences. Symmetrical gangrene (Raynaud's disease) and the so-called perforating ulcer of the foot (*mal perforant du pied*) also belong in this category.

Symmetrical gangrene (Raynaud's disease) occurs on the toes and fingers, seldom on other parts of the body, and appears in the form of attacks. It is probably conditioned upon vasomotor disturbances causing vascular spasm (*asphyxie locale*, Raynaud). This rare form of gangrene begins, as a rule, with numbness of the limbs and neuralgic pain. Cyanosis or anæmia of the involved toes then develops. The gangrene usually appears first on the terminal phalanx. It may remain superficial or the entire terminal phalanx may be cast off.

The so-called perforating ulcer of the foot (*mal perforant du pied* of the French) is a painless, crater-shaped ulceration of the sole of the foot, which gradually deepens. As was determined first by Duplay and later by Sonnenburg, H. Fischer, P. Bruns, and others, this form of gangrene is associated with sensory and vasomotor paralysis of the lower extremities. It is a symptom of the greatest variety of peripheral or central nervous disturbances.

Decubitus, or bedsore, is the result of continued pressure on some part of the body, usually in persons reduced by a long illness or in paralyzed patients. It also occurs after the prolonged use of splints, and is then frequently found on the back of the heel.

The Treatment of the Different Forms of Gangrene of the Foot and Toes is in part local and is directed in part against the cause of gangrene—e. g., against the diabetes, peripheral and central nervous diseases, etc. The local treatment conforms to antiseptic rules. Deodorizing powders, such as iodoform, bismuth, zinc oxide, naphthalene, etc., are useful, and the extremity may be elevated. Elevation of the extremity is often not endured in cases of senile gangrene, and a horizontal position is better here, and warm antiseptic poultices are more agreeable for the pa-

tient. The pain is controlled by morphine. Wet dressings of acetate of aluminium and warm antiseptic baths of permanganate of potash or salicylic acid are serviceable in hastening the demarcation. In case of extensive gangrene resulting, for example, from burns or frost-bites, it is a good plan to place the patient in a warm, full bath, or to employ antiseptic irrigation with a non-poisonous antiseptic, such as acetate of aluminium. After the line of demarcation has formed, or in case the gangrene spreads rapidly, amputation should be performed as far as possible from the limits of the gangrene, in order that the patient may not die of pyæmia and sepsis, or the formation of thrombi proceed any further. Amputation of the leg or the thigh may become necessary. If amputation is performed too near the boundary of the gangrene, the flaps can easily become gangrenous. If the gangrene has extended on to the dorsum or the sole of the foot, for example, amputation of the thigh just above the condyles is usually indicated. If the leg is amputated below the knee in such cases, gangrene of the flaps is very much to be feared. It is a good plan to determine the local temperature of the place where the amputation is to be performed. As a general rule, one should not amputate at a point where the temperature of the skin is lower than on the sound leg.

Syphilitic Ulcers of the Toes.—Syphilitic lesions of the toes sometimes take the form of inflammation of the nail bed and the vicinity of the nail (syphilitic onychia and paronychia). The symptoms are much the same as in ordinary ingrowing toe nail (see below), except that the secretion is more abundant and there is a fetid suppuration of the matrix. All syphilitic ulcers on the toes are characterized by a lardaceous base, induration, a usually livid red colour of the border of the ulcer, and often by surrounding condylomatous growths. Aside from onychia and paronychia, similar ulcerations are also observed between the toes in syphilis, with fetid suppuration and more or less severe inflammatory reaction. These ulcers usually develop from broad condylomata. The treatment is antisiphilitic (inunction, iodide of potassium; see Principles of Surgery, page 433 ff.), and use is made locally of iodoform, dermatol, zinc oxide or bismuth, cauterization, and ointments. Healing is most quickly brought about by excising the ulcers with curved scissors or with a knife, under local anæsthesia.

Ingrowing Toe Nail.—This condition is most frequently observed on the outer or inner border of the nail of the great toe, especially among persons with a broad lateral fold, who wear too pointed and narrow shoes. There is usually at first a simple onychia and paronychia—that is, an inflammation of the lateral fold and the matrix—e. g., from a superficial excoriation, in consequence of a slight injury or too narrow shoes. Granulations then form, and finally a painful ulcer, with more

or less abundant secretion. The worst forms, with sloughing of the matrix (*onychia maligna*), are, as a rule, of a syphilitic nature (see above).

In the early stages, when the lateral fold is not hypertrophied, simple removal of the edge of the nail is sufficient. In the more advanced stages the involved half of the nail or the whole of it may require removal. The point of a straight scissors is pushed beneath the nail, under local anæsthesia and elastic constriction of the base of the toe, the nail is divided into halves, and both halves are extracted with a dressing forceps or an artery clamp. The wound is dressed with iodoform gauze. The dressing is removed after twenty-four hours, leaving a portion of the gauze that has dried on and is adherent to the nail bed. If the wound heals without reaction, the patient can attend to business again on the third or fourth day. The aseptic scab then falls off of itself.

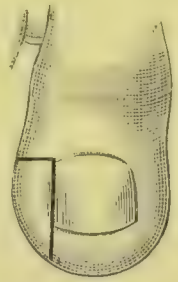


FIG. 894.—Operation for ingrowing toe nail. Excision of the lateral fold and the matrix.

Recurrences often occur after the removal of the nail if the lateral fold of skin is too broad. If recurrences are surely to be avoided, the hypertrophied fold and the matrix must be removed, as shown in Fig. 894. This is the best form of operation. Healing takes place very quickly under an aseptic scab.

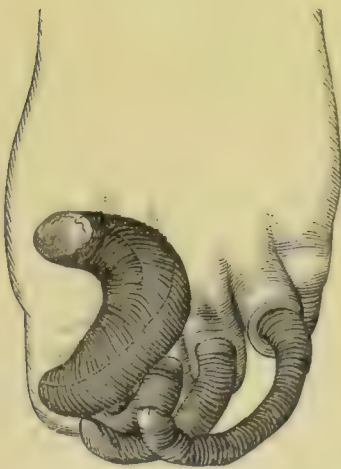


FIG. 895.—Onychogryphosis of all the toes in a woman seventy-two years of age (Nägeli).

All other methods of treatment of ingrowing toe nail, such as packing charpie, cotton, adhesive plaster, etc., beneath the nail, are insufficient, and it is surprising that physicians so often employ these methods for long periods without accomplishing anything.

By onychogryphosis (Fig. 895) is understood a tumourlike hypertrophy of the nail, causing it to become more or less thickened, curved, or twisted. In the milder forms the nail is simply thickened, particularly in those individuals who have not the habit of cutting them properly and regularly or who are unclean. The nails may finally become so much thickened and deformed that they can only be removed with a small saw or bone-cutting forceps.

Chronic inflammations of the nail bed (*onychomycosis*) arise in consequence of the growth of microbes, especially mould fungi, under the lateral fold and the nail, combined with marked thickening and brittleness of the latter. A rapid cure is effected by removing the nail and disinfecting the nail bed with 1-in-1,000 bichloride of mercury.

For other diseases of the toes and nails see also page 660 ff.

Blisters on the foot and toes, which are caused by pressure, arise particularly from wearing too tight shoes. The blisters are at first filled with serum and usually later with pus. Lymphangitis, erysipelas, or severe cellulitis may ensue from infection and excoriation of the small wound, much as they are observed on the fingers after slight injuries. The treatment of these blisters caused by pressure consists in evacuating their contents and cutting away the loose skin and then covering the small wound with liquor plumbi subacetatis, dermatol, iodoform, bismuth, or some ointment.

Callosities are dense thickenings of the epidermis and arise especially from the pressure of the boot, particularly against the head of the metatarsal bone of the great toe and the little toe, the dorsum of the toes, the sole of the foot, and the heel. Callosities are either flat formations or they are raised somewhat above the surface, forming the familiar corns or bunions. They may become very painful in consequence of secondary inflammation. A secondary small bursa is not infrequently found under large corns or bunions, especially over the head of the metatarsal bone of the large toe and the small toe, which may communicate with the underlying joint or the tendon sheath. Severe or even septic cellulitis, resulting in amputation or sometimes in death, may follow infection after cutting a corn, with suppurative inflammation of this small bursa, if suitable treatment is not promptly begun. The fistulæ that are sometimes found leading into a bursa in connection with corns are of practical importance. They may cause frequently recurring inflammations and retention of pus. A rapid cure is accomplished by removing the edges of the small inflamed bursa or the fistula with scissors or a pointed knife, or completely excising the inflamed area under local anæsthesia, or removing it by galvano-caustic ustion. If the bursa communicates with the joint, the strictest asepsis is necessary, both in the operation and during the after-treatment.

The treatment of calluses or corns consists, above all, in wearing suitable shoes. The shoe should not be too pointed, and the heel should be broad and not too high (so-called English heel). Corns are most surely and permanently cured by frequent bathing and regular cutting of the calluses with a clean knife and by wearing suitable shoes. In case of inflammatory symptoms the so-called corn rings are serviceable. Inflamed corns can also be relieved from pressure by rings of adhesive plaster laid one upon another, and these are a good substitute for the rings just mentioned. Inflammatory processes are to be treated according to general rules. Undermined calluses, with or without fistulæ, are simply removed with the knife.

Sweating of the feet, which is a great annoyance, especially in summer, is treated by smearing the foot with unguentum diachylon or powdering it with zinc oxide, amylum, salicylic acid, etc. Stockings and shoes are to be frequently changed. The treatment with chromic acid is also strongly to be recommended, according to the experience gained in the Prussian army; 59·4 per cent of those treated with this remedy were cured, 33·1 per cent were benefited, and only 7·5 per cent were not helped. After washing the foot thoroughly, a five-per-cent solution is applied to the skin with a camel's-hair brush in the evening, at intervals of from one to two weeks. After it has dried, shoes and stockings can be drawn on. If itching and burning result from applying the chromic acid, a mixture of tallow and salicylic acid is rubbed in.

The so-called chilblains (*perniones*) arise from slight and repeated freezings of the toes and fingers. The extensor sides of the toes in particular are usually the seat of a dark-red or more lightish-red swelling, which inclines to ulceration and tortures the patient with severe burning and itching, especially after getting warm in bed, during the change from freezing to thawing weather, and in summer. Persons who are obliged to change frequently from warm to cold rooms are particularly likely to have chilblains. A great number of remedies for this trouble have been recommended. One should always have in mind the general condition of the patient, and, as a precautionary measure, recommend warm clothing for the feet at the beginning of the cold season. If chilblains already exist, one should try rubbing with snow, ice water, ice poultices, hydropathic packing, applying collodion, traumaticin, cabinet-maker's glue or tincture of iodine, mild caustics (dilute hydrochloric acid, one part to twenty-five or thirty of water, tincture of cantharides), strips of adhesive plaster, etc. Various ointments for frost-bitten parts have been recommended. Ulceration from frostbite is best treated with iodoform, dermatol, zinc oxide, bismuth, and ointments (*unguentum diachylon*, boric ointment, etc.).

The treatment of other inflammations of the foot and the toes—e. g., *eczema*, *erythema*, acute and chronic inflammations of the tendon sheaths—is the same as in other parts of the body—e. g., on the upper extremity.

§ 362. **Congenital and Acquired Deformities of the Foot.**—Much the same congenital malformations occur on the foot and the toes as on the hand and the fingers—e. g., *syndactylism*, *polydactylism*, absence of toes (Fig. 896), giant growth of the toes (*macroductylism*) of the entire foot or of the lower extremity. For all these malformations, which are of but little surgical interest, the reader is referred to page 646 ff, where similar malformations of the hand were briefly mentioned. For giant growth see also *Principles of Surgery*, page 650, Fig. 362.



FIG. 896.—Congenital absence of the second and fourth toes.

Congenital dislocations of the ankle joint are rare. Outward and inward dislocations are the most common, and are usually associated with defective development of one of the malleoli. These abnormal positions of the foot attending congenital defects or rudimentary development of the lower end of the tibia or fibula are not, however, to be regarded as dislocations. They are really genuine malformations or congenital *contractures* of the ankle joint. Volkmann saw a case of double rudimentary development of the tibia and especially the fibula in father and

son, with corresponding deformity (valgus position) of the ankle joint (Fig. 897). Billroth and the author have seen complete supination or varus position of the foot as the result of absence of the tibia (Fig.



FIG. 897.—Rudimentary development of both tibiae and particularly both fibulae with corresponding deformity of the ankle joints.



FIG. 898.—Congenital supination contracture of the right foot, or rather dislocation of the foot inward (varus position), in consequence of congenital absence of the entire tibia.

898). In case of defect of the lower end of the fibula, the foot assumes a valgus position, as in Fig. 897. Congenital defect of the fibula is by no means very rare. Busachi and Orlalda collected seventy-nine such cases from literature. Satisfactory functional results may be secured in cases of congenital defects of the fibula or tibia by prompt orthopaedic treatment (tenotomy of the tendo Achillis, massage, the use of braces, arthrodesis, it may be, etc.). The most important congenital deformity of the foot with which we shall occupy ourselves is clubfoot (pes varus, see page 882), which may also be acquired.

Henke described a congenital bending of the metatarsus toward the inner side of the tarsus (congenital adduction contracture of the metatarsus), which probably arose from abnormal pressure in the uterus. The treatment is similar to that of pes varus.

The other deformities or contractures of the ankle joint, of the foot, and of the toes are in part congenital and in part acquired. The field of congenital and acquired contractures of the foot is very large and of eminent practical importance. We distinguish four principal forms of deformities or contractures of the foot: 1, Pes equinus (excessive plantar flexion); 2, pes calcaneus (excessive dorsal flexion); 3, clubfoot (pes varus, inversion with adduction); 4, flat foot (pes valgus, eversion with abduction); 5, combined forms—e. g., pes equino-varus, pes valgo-calcaneus, etc.

The acquired contractures of the ankle joint arise in the same way as other contractures of joints—that is, they are due to conditions either inside the joint or outside the joint—e. g., cicatricial contractions in the vicinity of the ankle and the muscles of the calf following cellulitis, burns, etc. In other cases we have to do with paralytic or spastic contractures of the foot, for which the reader is referred to page 787. The treatment of acquired contractures of the ankle joint conforms to general rules, as given more fully for the knee joint, for example, on page 788 ff. For tenoplasty, by Sporon's method, and for lengthening shortened (retracted) tendons, see *Principles of Surgery*, page 467. We shall take up below the nature and the treatment of pes equinus, pes varus, pes calcaneus, and pes valgus.

Of the acquired contractures of the toes two require a special description—viz., hallux valgus and hammer-toe.

Hallux Valgus.—By hallux valgus is understood an abduction contracture of the great toe, which arises particularly from wearing pointed shoes for a long time. The toes are thus pressed together, the great toe is abducted, and, in severe cases, the great toe lies under the others (Fig. 899). Furthermore, the little toe and the fourth toe are pressed inward by too pointed shoes, so that they sometimes lie on top of or under the third toe. Hallux valgus often begins in youth at the time of the most active growth of bone. It then becomes more and more fixed by changes in the ends of the bones, even after the growth of bone has ceased, and by gradual shortening of the flexor and extensor tendons, which become displaced outward. The metatarso-phalangeal joint gradually changes its shape, the cartilaginous surfaces are correspondingly displaced, and finally arthritis deformans results, with thickening of the ends of the bones, erosion of the cartilage, thickening of the capsule, etc. A bursa is usually formed over the projecting head of the metatarsal bone, which frequently occasions intermittent inflammations, so that the affection is often very annoying.



FIG. 899.—Hallux valgus.

The treatment of hallux valgus consists mainly, by way of precaution, in wearing suitable, not too pointed shoes. When already present it can also be prevented in this way from growing worse. If it has once developed, nothing is to be expected from other orthopædic measures, from the wearing of apparatus, from tenotomy, or from forcible reduction with the application of a plaster-of-Paris bandage. Equally

fruitless is the wearing of a sandal with a steel spring for adducting the great toe (Pitha). Lothrop's simple device is of little avail permanently. He put on a glove finger over the great toe, which was then fastened by means of a strip of adhesive plaster to the inner side of the heel. If the hallux valgus causes much trouble—e. g., on account of arthritis deformans and recurring inflammations of the joint and its vicinity—a complete cure is most quickly effected by resection of the metatarso-phalangeal joint. A longitudinal incision is made over the inner border of the joint; the metatarsal bone is resected, and also, it may be, the articular surface of the phalanx of the toe, the thickened capsule and the bursa are excised as completely as possible, the toe is straightened, and rapid healing is attained under an aseptic dressing. Most of my patients were able to walk again after a few days even, but in other cases complete healing was delayed for some time, although there was no suppuration.

Hammer-toe.—Permanent angular flexion of one or more of the toes sometimes occurs, and may be congenital or acquired at the period of the growth of the bone, in consequence of wearing short shoes, or from paralysis. The first phalangeal joint of the second toe is most frequently affected; the first phalanx is extended, and the second and third flexed at right angles. This deformity may occur on the other toes and particularly at the metatarso-phalangeal joint of the great toe. In the latter case flat foot finally develops in consequence of a sinking in of the arch of the foot from the abnormal distribution of the weight supported by the foot. Such individuals suffer a good deal, especially after walking a long distance, and in consequence of callosities and inflammations on the dorsal surface of the toes. The disability was so great in the case of an officer that he wished to resign his commission, and a young woman who had been in the habit of wearing too small shoes was finally unable to dance any more or to take long walks.

On account of the increasing deformity of the foot that it entails, hammer-toe should receive prompt treatment. It can usually be overcome by tenotomy of the extensor tendons, and, if necessary, of the flexor tendons also, by open transverse division of the skin, the tendon, and the capsule (Petersen), by cuneiform osteotomy, and, above all, by resection of the joint in question. It is sometimes a good plan after the operation to wear, especially at night, wooden sandals with a heel piece prepared for the sole of the foot from a plaster-of-Paris cast. The toes are extended and the foot is secured to a long wooden sandal, which should extend beyond the foot in front. Long shoes with a low heel should ultimately be worn, and the flat foot should be supported in the usual way (page 889).

The treatment of other contractures of the toes and the small tarsal and metatarsal joints is the same as that of similar deformities of the hand.

§ 363. **Pes Equinus.**—By pes equinus (Fig. 900) is understood a plantar contracture—i. e., an increased plantar flexion of the ankle. The most frequent cause of pes equinus is paralysis (pes equinus para-

lyticus). In case of paralysis of the muscles of the leg, the flexors as well as the extensors, the foot, which is not held firmly at the ankle joint, falls into plantar flexion simply of its own weight. In consequence of this flexion the extensor muscles on the anterior aspect of the leg are stretched, while the muscles of the calf, on the contrary, undergo shortening as a result of the permanent approximation of their points of insertion. The pes equinus becomes more and more fixed in this way, and the range of passive movement at the ankle joint is also increasingly restricted. The character of the paralysis, whether it be that of the anterior or posterior tibial nerve, makes no difference. If the patient remains lying and does not walk, a pes-equinus position gradually develops in every case if preventive measures are not adopted. The same thing is observed simply in consequence of long confinement in bed when the muscles are not at all paralyzed. Here also the foot sinks into plantar flexion, though in a less degree, to be sure, in consequence of its weight. Walking has also an important influence. In the case of patients with partial paralysis of the muscles of the leg who can walk with the foot placed on the ground at right angles, the act of walking works against the development of pes equinus. The shortening of the muscles of the calf is then absent when paralysis of the extensor muscles (dorsal flexion)

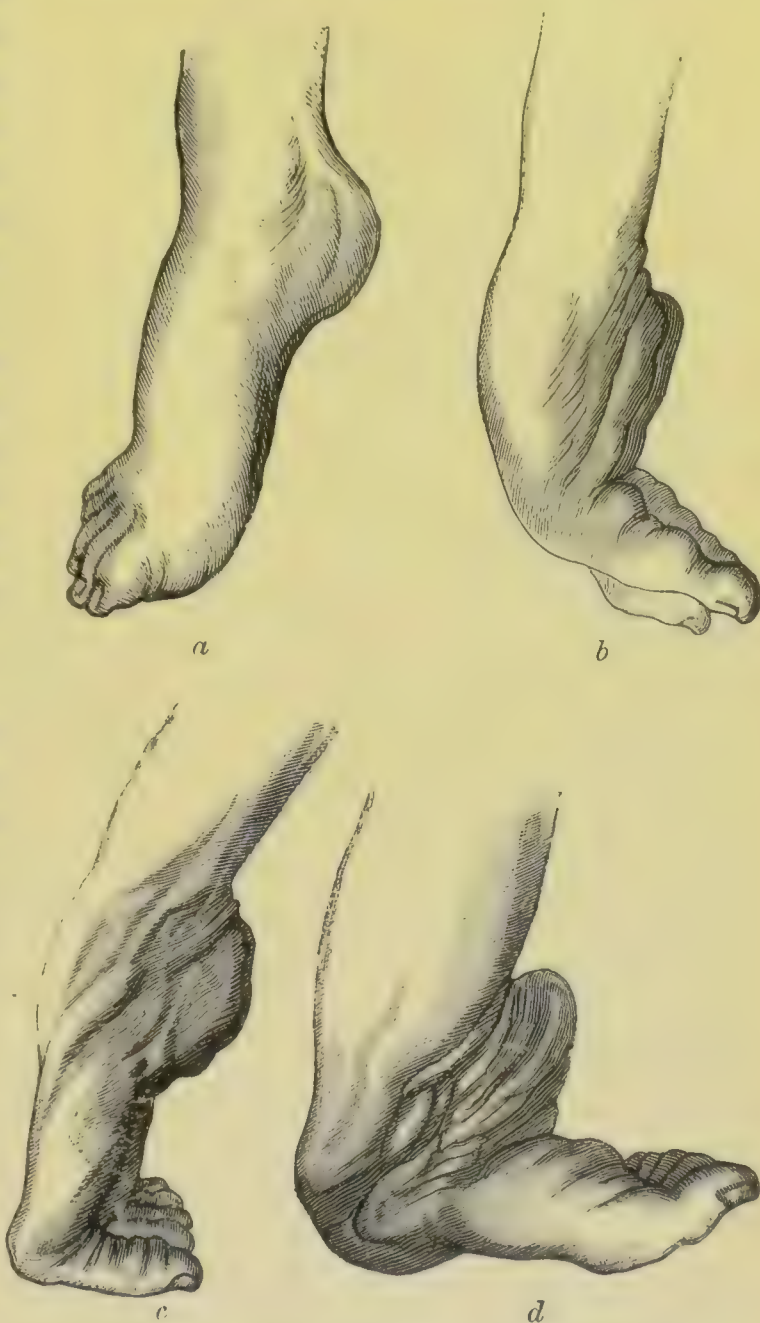


FIG. 900.—The different degrees of paralytic pes equinus (Volkmann).

predominates, and if the muscles of the calf are paralyzed the extensors can hold the foot in a right-angled position. No contracture more simply and convincingly proves the error of the antagonistic theory, according to which the direction of the paralytic contracture is always determined by the action of the non-paralyzed antagonistic muscles.

Pes equinus occurs most frequently in connection with infantile paralysis and other forms of paralysis, also in a less degree among patients who have become very much weakened in consequence of protracted confinement in bed if the foot is exposed to the constant pressure of the bed-clothes and is not fixed at right angles. For the latter reason it also occurs in diseases of the ankle joint. *Pes equinus* is also observed occasionally as the result of cicatricial contraction—e. g., after burns, skin defects, and cellulitis in the region of the calf of the leg.

The clinical phenomena of *pes equinus* are easily understood from what has been said. We sometimes have to do with a contracture of the ankle joint exclusively, but in the later stages the two astragalo-tarsal joints become more and more involved—that is, inversion and adduction of the foot are added, giving rise to a *pes equino-varus*. The longer the contracture exists the more fixed does it become in consequence of shortening of the muscles of the calf, especially when there is paralysis, also in consequence of contraction of the capsule and the ligaments. The inner structure and the outer form of the bones and the cartilage are also changed secondarily. In the later stages there is often a pronounced *pes cavus* or hollow foot, because the arch of the foot is simply pressed together from the action of the weight of the foot, which is in plantar flexion. Pure *pes cavus* without *pes equinus* is, as is well known, a peculiarity of the feet of Chinese women, the ends of which even in early youth are approximated to the heel by means of bandages for the sake of shortening the foot.

In the later stages of *pes equinus* the toes are often extended, in consequence of the contraction of the *extensor communis digitorum*, the *extensor longus digitorum*, and the *extensor brevis digitorum* muscles. The plantar fascia and the plantar muscles, on the contrary, are secondarily shortened. The contractures represented in Fig. 900 *c* and *d* are observed in the more marked forms, in consequence of the weight of the body, if the limbs are used in standing and walking—that is, the patients walk upon the dorsal surface of the toes or upon the dorsum of the foot, especially in case of paralytic *pes equinus* acquired in childhood.

Treatment of *Pes Equinus*.—From a prophylactic standpoint emphasis should be laid, to begin with, upon the importance of preventing

the development of a pes equinus in all chronic diseases of the lower extremities, and particularly when there is long confinement in bed, by maintaining the foot at right angles. The treatment of an already existing pes equinus is directed partly against the cause that is at work and also against the deformity itself. In case of peripheral paralysis arising, for example, from a wound, neurorrhaphy, electricity, and massage may be indicated. In case of central paralysis (infantile paralysis) one should likewise seek to preserve the electrical contractibility of the muscles by the use of electricity and massage. In case of cicatricial contraction of the muscles of the calf, tenotomy of the tendo Achillis should be performed, and use should be made of active and passive movements and massage. In pes equinus resulting from cicatricial contraction of the skin the cicatrix should be divided and the defect covered with pedunculated flaps from the immediate vicinity or from the other leg (see Principles of Surgery, page 141) or skin-grafted.

The treatment of the contracture itself is as follows: In the first stages the plantar flexion is forcibly corrected, with the patient under an anæsthetic, if necessary, and the foot fixed at right angles by means of a plaster splint, or, better, by means of removable felt bandages, a water-glass splint, or some form of apparatus, in order that passive movements, particularly dorsal flexion, and massage may be applied daily. The patient must then, above all, walk about. Among the different forms of apparatus for this purpose that of Bauer, with elastic traction on the end of the foot (Fig. 901), is especially to be mentioned. The foot is kept at right angles in a less noticeable way than by the employment of Bauer's apparatus, if lever springs are attached to both sides of a laced boot having two lateral steel splints. These hold the foot at right angles, in place of the muscles of the calf, which do not perform their function. Braces with lateral splints and a pelvic girdle, for both legs, it may be, as represented in Fig.

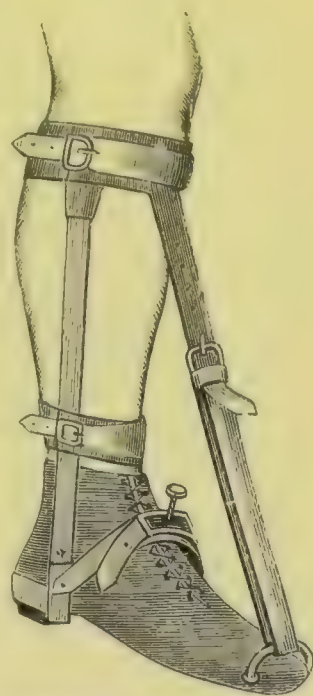


FIG. 901.—Bauer's apparatus for the treatment of pes equinus.

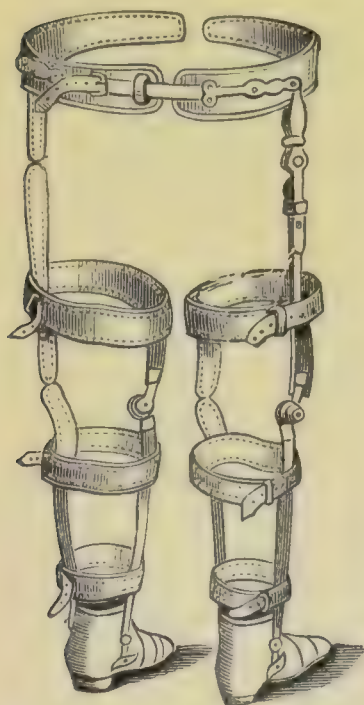


FIG. 902.—Brace with pelvic girdle for both legs for the treatment of paralysis of the lower extremity, double pes valgus, etc.

902, are used in case of severe paralysis of the muscles of the leg or of the whole lower extremity.

In the later stages of pes equinus tenotomy of the tendo Achillis is frequently a necessary preliminary to forcible manual correction of the contracture. The muscle is put on the stretch by dorsal flexion of the foot, and a pointed knife is then inserted, from the inside on the right foot and the outside on the left foot, close behind the tendon and a little above the tuberosity of the os calcis. The point of the knife is located under the skin by placing the left forefinger on the opposite side, and the tendon is now severed by carefully moving the knife to and fro. The last remnant of the tendon is torn apart by dorsal flexion of the foot. After complete division of the tendon the foot assumes a position of dorsal flexion, and the separated ends of the tendon can be felt under the skin. The skin must not be pierced on the opposite side by the point of the knife. Injury of the posterior tibial artery near the internal malleolus is scarcely possible. The wound is dressed antiseptically, and the foot maintained in a position of dorsal flexion for



FIG. 903.—Paralytic pes calcaneus.

the next four or five days, and orthopædic treatment is then begun (active and passive movements, exercise in walking, etc.). In case of complication of pes equinus with pes cavus or with pes varus, division of the plantar fascia and the short plantar muscles is often necessary (see § 365, page 882 ff., pes varus), but is, generally speaking, of but little effect, because the form of the bones has usually become changed.

More is accomplished in such cases by forcibly straightening the arch of the foot under an anæsthetic, thus fracturing the tarsal bones. A removable splint of some sort is then applied, with the foot in a corrected position, and passive movements and massage are employed daily.

Finally, it is a very good plan to treat paralytic deformities and loose joints by resection of the ankle joint, or better by arthrodesis (see pages 535 and 901)—that is, the formation of an artificial ankylosis.

§ 364. **Pes Calcaneus.**—Pes calcaneus (Fig. 903) is the opposite of pes equinus—that is, the ankle is flexed in a dorsal position and the patient walks upon the os calcis. It may be either congenital or acquired. Acquired pes calcaneus is usually a result of paralysis, and is then generally combined with pes valgus (pes calcaneo-valgus, Fig. 904). Paralytic pes calcaneus and pes calcaneo-valgus occur most commonly from

spinal and cerebral infantile paralysis, from injuries, and from other affections which prevent the heel from being raised from the ground, and thus interfere with the normal function of the foot in walking. The os calcis, not being held firmly by the muscles of the calf, becomes flexed. The weight of the foot and the pressure of the weight of the body in walking prevent more or less the development of paralytic pes calcaneus.

Pes calcaneus also occurs congenitally, mostly as pes calcaneo-valgus, in consequence of abnormal pressure in the uterus (Fig. 904). A proof of the occurrence of this intra-uterine pressure is furnished by the fact that Volkmann observed a characteristic callosity produced by pressure in connection with congenital pes calcaneo-valgus. A slight degree of pes calcaneus exists physiologically

among infants, in consequence of contraction of the extensor tendons conditioned upon the position of the foetus. Children therefore tread upon the heel in their first attempts to walk. It is only in rare cases that this physiological pes calcaneus reaches such a degree as to become pathological. This occurs most often in stillborn foetuses and when there is a congenital abnormality of the central nervous system.

The essential anatomical changes attending congenital pes calcaneus affect, according to Messner, the os calcis and the astragalus. The latter is much flatter and longer and the former is abnormally strongly developed in its anterior part. The anterior process of the os calcis in particular is very long and the sustentaculum tali is more weakly developed. Particularly in paralytic pes calcaneus the posterior process of the os calcis is hypertrophic and drawn downward on account of the one-sided traction of the sole of the foot, while the counter-traction of the paralyzed muscles of the calf is absent. The articular surfaces of the astragalus and os calcis, and of the cuboid and scaphoid, show changed lines of direction corre-

sponding to the abnormal position of the foot.

The treatment of congenital pes calcaneus consists in daily plantar flexion of the foot and fixation of the same in this position by means



FIG. 904.—Congenital pes calcaneo-valgus.

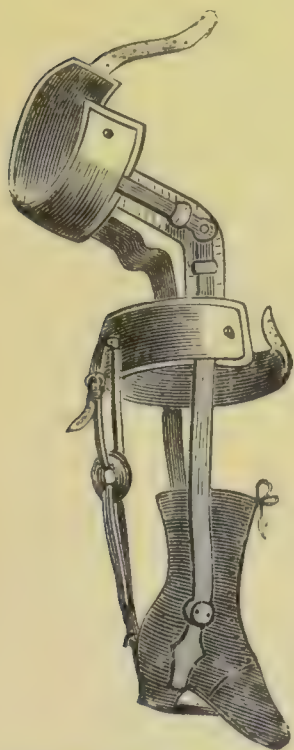


FIG. 905.—Splint apparatus with elastic traction on the heel for the treatment of paralytic pes calcaneus (Volkmann).

of a splint applied to the anterior surface of the leg and the dorsum of the foot, thick pads of wadding being inserted between the leg and the dorsum of the foot (Roser).

The treatment of paralytic pes calcaneus is similar to that of paralytic pes equinus (see pages 879, 880). Volkmann used an excellent brace (Fig. 905) with elastic traction upon the heel (in place of the gastrocnemius muscle). It can also be used after resection of the ankle for causing movements of the joint in walking, if there is any prospect that a movable joint can be secured after the resection. In suitable cases of pes calcaneus, arthrodesis should be performed (see pages 535 and 901).

§ 365. **Pes Varus (Clubfoot).**—Clubfoot (Fig. 906) is a supination and adduction contracture, and, inasmuch as supination and adduction are executed in the astragalo-tarsal joints, pes varus is really to be designated as a contracture of these two joints. Clubfoot is sometimes congenital and sometimes acquired. Congenital clubfoot is present, according to Dieffenbach and Bessel-Hagen, in one out of every ten to twelve hundred children. It is nearly twice as frequent among boys as girls, and is double in more than half the cases that occur.

Acquired clubfoot sometimes occurs after paralysis, and is then almost always combined with an equinus position (pes varo-equinus). This para-



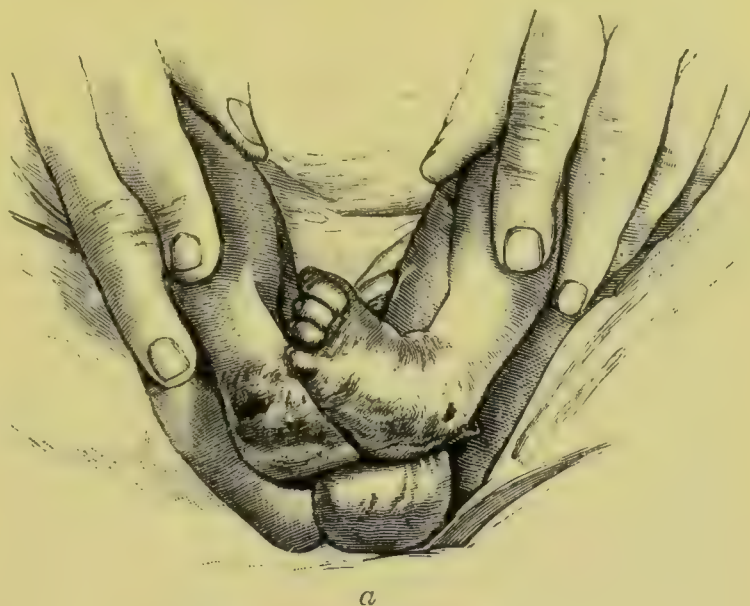
FIG. 906.—Pes varus (club-foot).

lytic pes varo-equinus likewise develops in consequence of the weight of the foot if the persons affected do not walk about. The foot assumes a position of plantar flexion from its own weight, and rotates at the same time into supination and adduction, because the heavier portion of the foot lies to the outer side of the axis of rotation. A pes equino-varus may develop in the same way among young individuals who have become much weakened in consequence of long confinement in bed. If in case of paralysis the patient walks about, the varo-equinus position does not develop. On the contrary, the opposite, a paralytic pes valgus, ensues—that is, a pronation contracture (with depression of the inner border of the foot), because the paralyzed muscles

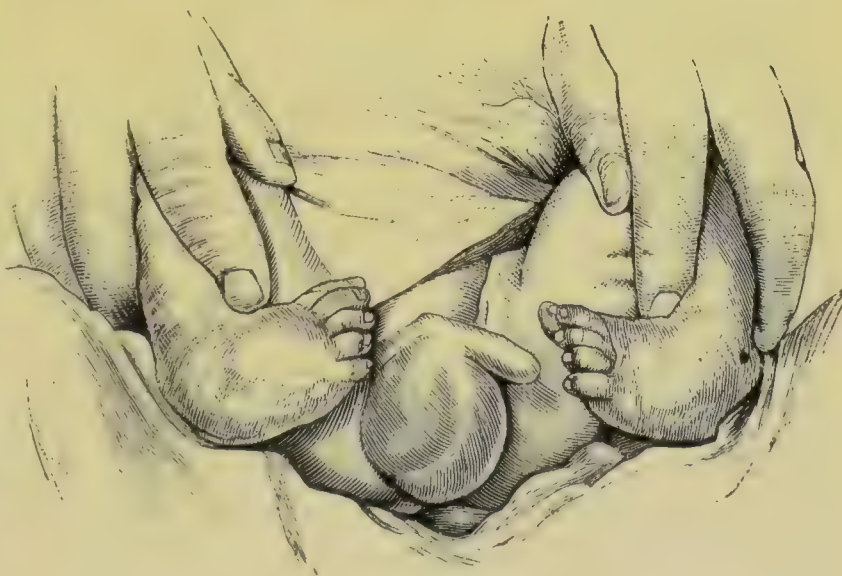
offer no resistance to the pronating force of the weight of the body. Pes varus also develops occasionally as the result of other pathological conditions of the tarsal joints, especially the astragalo-tarsal joints, after malunion of fractures of the tibia, after unreduced dislocations of the ankle, and after subastragaloid dislocations, especially unreduced dislocations inward.

Congenital clubfoot is of special interest and great practical importance. This also is usually a pes equino-varus and may be either single or double. In the former case it is more common on the left side than on the right. The degree of clubfoot is very variable.

Ætiology of Congenital Pes Varus.—Congenital pes varus is, in very rare cases, paralytic, and is then due to some congenital abnormality of the central nervous system. In the majority of cases it is based upon a supination contracture of the muscles with a corresponding shortening of the ligaments and fasciæ and upon a disturbance of development of the bones and joints of the tarsus, especially the astragalus and the astragalo-tarsal joints. A slight degree of congenital pes varus is physiological — that is, all children have it in a mild form at birth, and pathological pes varus is therefore nothing more than an excessive development of the physiological club-foot. The physiological congenital pes varus disappears spontaneously after birth as the result of walking and standing — that is, from the action of the weight of the body. The pathological congenital pes varus continues after birth and later, because it becomes more or less fixed, as the result of corresponding changes in the bones and joints. The deformity, in fact, increases in consequence of the abnormal growth of the bones if it is not overcome by suitable treatment. The physiological clubfoot of infants is, no doubt, a result of the continued supination of the foot during the intra-uterine development of the child. If this physiological supination of the foot is increased in the uterus by special circumstances, there then develops the pathological pes varus, as the result of the change in the growth of the tarsal bones, which have an increased growth in the parts that are free from pressure, while the growth is diminished in those parts where pressure is exerted. The supination contracture of pes varus thus becomes fixed even in the uterus, owing to this abnormal growth



a



b

FIG. 907.—Development of congenital pes varus from insufficient room in the uterus, with pressure marks on the feet.

of the tarsal bones and the corresponding displacement of the joints, the tendons, and the ligaments (Henke, Kocher). The views of anatomists and surgeons are now divided, in so far as some—e. g., Heinrich von Meyer and others—consider the contraction of the muscles as primary and the changes in the bones and joints as secondary, while others assume precisely the opposite.



FIG. 908.—Congenital pes varus and pes valgus.

What is the origin of this increased supination of the foot in the uterus? Different agencies undoubtedly play a part here, with which we are as yet acquainted only in part. In a large number of cases the increased supination arises from an abnormal position of the foetus in the uterus, and especially from a disproportion in size between the foetus and the uterine cavity—that is, from compression of the foetus in a uterine cavity that is too small or contains too little liquor amnii (Hippocrates, Paré, Malgaigne, Banga). Banga has described two cases which can be regarded as good proofs of the origin of pes varus from lack of room in the uterus (Fig. 907). Pressure marks were found on the feet in both cases. These pressure marks or callosities have been found in a number of cases in infants with clubfoot. Other deformities of the foot

also arise from this lack of space in the uterus, especially pes calcaneo-valgus (the highest degree of flat foot), congenital dislocation of the foot, congenital dislocation of the hip (see page 693, Fig. 782), contracture of the knee, torticollis, and in rare cases congenital scoliosis, etc. The action of pressure from lack of space in the uterus is illustrated by an interesting case observed by Volkmann. In this case there was a congenital pes varus on one side and pes valgus on the other side. The feet fitted exactly into one another (Fig. 908).

This does not mean, of course, that congenital pes varus is caused exclusively by lack of room in the uterine cavity, but this cause is by far the most common one. The development of clubfoot begins in these cases, contrary to Hueter's view, only in the later stages of intra-uterine life, in its latter half, when the disproportion between the size of the child and the uterine cavity is constantly increasing. There occurs at this time, as is well known, a normal diminution in the amount of amniotic fluid. Pes varus is conditioned in rare cases, as has already been mentioned, upon absence of the tibia (see page 874, Fig. 898), or upon paralysis resulting from some congenital abnormality of the central nervous system. Hereditary pes varus has been repeatedly observed.

Anatomical Changes associated with Congenital Pes Varus.—In the first place the form of the tarsal bones and the position of the joints are altered in correspondence with the supination contracture. Growth at the parts of the bones of the foot where abnormal pressure has been exerted is diminished, while it is increased at the parts which are free from pressure.

The tarsal bones that undergo the greatest amount of change are the astragalus and the os calcis. The body of the astragalus becomes flattened and wedge-shaped, is in a position of plantar flexion and adduction, and its

neck is lengthened and bent downward and inward. The anterior process of the os calcis, which is directed inward, is abnormally high, whereby pronation in the astragalo-tarsal joint is inhibited, while the sustentaculum tali, which inhibits supination, is very low or may even be entirely absent. The outer tubercle of the os calcis is approximated to the external malleolus, and the middle fasciculus of the external lateral ligament is considerably shortened. The astragalo-tarsal joints as well as the articulations of the cuneiform bones are displaced, corresponding to the position of supination. The mechanism of the ankle joint is also changed to correspond with the abnormal form of the astragalus. Hueter found a supernumerary joint between the internal malleolus and the inner border of the scaphoid and another between the posterior border of the external malleolus and the outer surface of the os calcis. The muscles themselves are usually normally developed in the infant, except that the tendon of the peroneus longus muscle often runs beneath the foot in a groove in the os calcis, and not, as is normal, in a groove in the cuboid. The involved muscles, however, especially the tibialis posticus, are shortened, answering to the supination contracture. Of special importance, from a therapeutic standpoint as well, is the outward rotation of the thigh, which frequently, in fact almost always, exists (Berg, Scudder), as is also the inward rotation of the leg.

There are essentially the same anatomical changes in clubfeet that have already been used in walking, and later among adults, as those observed among infants. Here also the bones are changed in form, the joints are correspondingly displaced, and the muscles and tendons have adapted themselves to the changed position of the foot. The muscles of the leg are more or less atrophic in adults as a result of their inactivity.

After what has been said, we need speak but very briefly regarding the clinical course and the prognosis of congenital pes varus. The degrees of clubfoot are very varied. There usually exist but slight changes during the first year. If, however, the clubfoot is then used for walking and standing, the deformity grows progressively worse. The supination increases under the pressure exerted by the weight of the body if the position of the foot is not corrected by some form of apparatus. Children walk at first upon the outer part of the sole. Later, however (very early in severe cases), the child supports himself more and more upon the outer border of the foot or upon its dorsum, in consequence of the increased supination, so that the sole of the foot is directed inward and upward. The dorsum of the foot takes on a sole-like, callous character, and subcutaneous bursæ are formed at the points of greatest pressure, whereby the skin becomes displaceable. The foot is used by the patient like a stilt. In time the bones and joints become more and more misformed by the abnormal growth of bone, and the muscles become more and more atrophic from fatty and fibrous degeneration owing to disuse, so that the leg in the course of years comes to consist only of skin and bone. The bones of the leg and the foot are

shortened as a result of the diminished growth of bone. In the severe cases of clubfoot the bones of the leg are rotated inward, while the knee and the thigh are rotated outward.

The treatment of congenital pes varus should begin as early as possible in the first months after birth. The longer one waits the more marked and the more fixed does the deformity become in consequence of the rapid growth of the bones. The treatment of clubfoot is very varied. I usually follow the principles laid down by G. Krauss, Czerny, Tilanus, Guerin, König, Julius Wolff, Shaffer, and others. These include, briefly stated, the purely orthopædic treatment and forcible straightening of the foot by means of subcutaneous rupture of tissue, aided by incision of the soft parts. Operations on the bones are advisable only in old cases.

The treatment of congenital clubfoot is as follows: The tendo Achillis (see page 880) and the plantar fascia at the inner border of the foot are divided under an anæsthetic. In case of marked pes equino-varus the tendons of the tibialis posticus, flexor digitorum longus, and tibialis anticus (Brod-

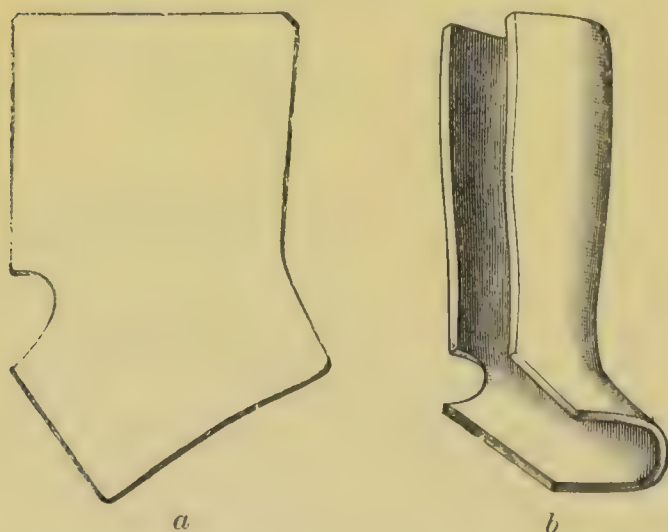


FIG. 909.—*a*, model for plastic splint for clubfoot; *b*, splint moulded to the extremity (König).

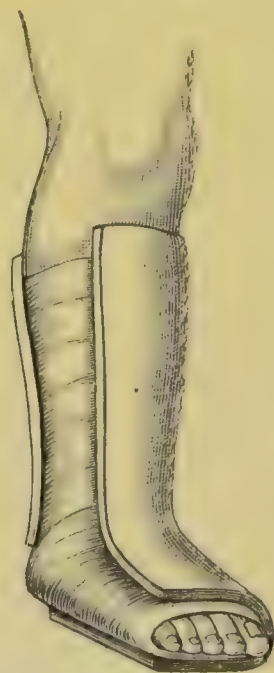


FIG. 910.—Plastic splint applied to the extremity.

hurst) are divided subcutaneously. In older refractory cases the additional division of the internal lateral ligament is very effective. In mild cases tenotomy is often unnecessary. The after-treatment is begun after a few days, consisting in traction and pressure by means of suitable shoes (see page 887), or forcible correction of the deformity is employed by pressing the bones together on the convexity of the curvature and rupturing the ligaments or their insertions on the inner side (concavity) of the foot (König). König's method of straightening the foot consists of two stages. I overcome the deformity, like König, in

two stages, but somewhat differently. First, the supination is overcome. The patient being under an anæsthetic, and the knee and leg firmly held by an assistant, the outer side of the tarsus is placed upon a piece of wood similar to Volkmann's sliding foot-rest, the front part of the foot is grasped with one hand and the ankle joint and the os calcis with the other, and the

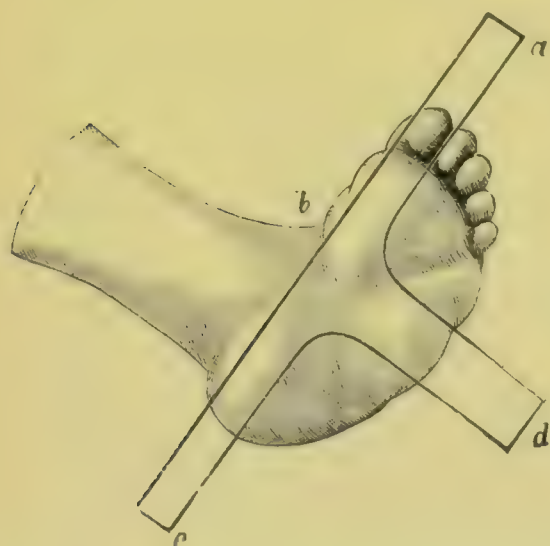


FIG. 911.—Hahn's wooden splint, *a b c d*, for clubfoot.

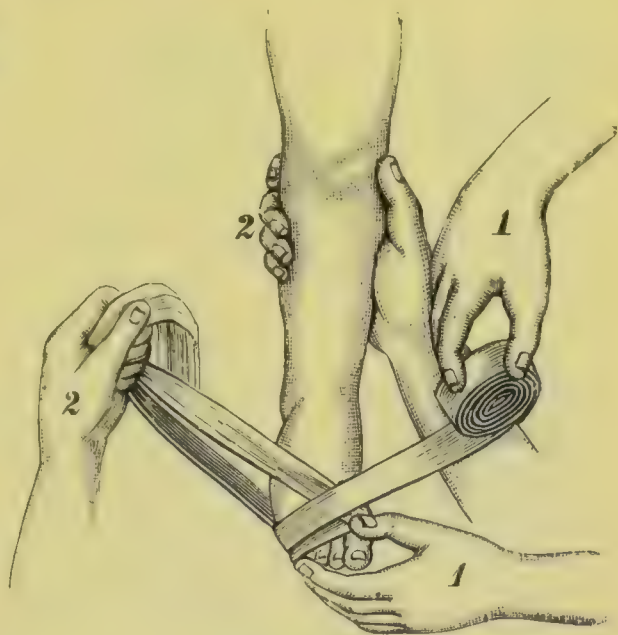


FIG. 912.—Application of a bandage to a clubfoot with the help of a sling for holding the foot in a corrected position (Hueter).

foot is everted as strongly as possible until it yields with a distinct crackling. Now follows the second part of König's method—that is, the foot is brought forcibly into dorsal flexion and abduction. The two parts of the procedure sometimes have to be repeated two or three times at one sitting. In old cases it is a good plan to use the osteoclast of Lorenz or Delore in straightening the foot. After correction of the deformity the foot is immobilized by a brace (Fig. 913), plaster splint, or a splint of some plastic material (see Figs. 909 and 910). Removable water-glass splints are also very good for the purpose. In severe cases I apply a plaster splint for two or three weeks with the foot overcorrected, and include in the plaster a foot-board which extends some distance beyond the heel. This compels the foot to remain in dorsal flexion and the heel to rest with a broad surface on the ground. Hahn recommends the splint shown in Fig. 911, which is included in the plaster and forces the foot outward. During the application of the plaster splint the foot may be held in its corrected position by means

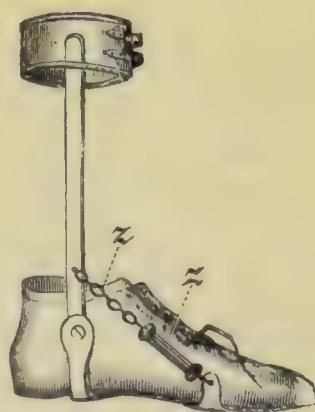


FIG. 913.—Barwell's shoe for clubfoot: *z*, elastic traction

of a sling, as shown in Fig. 912. For small children I use the shoe recommended by Petersen. Older individuals are allowed to walk about in a plaster splint or a special shoe—e. g., Roser's, Barwell's, or Sayre's (Figs. 913 and 914). In severe cases splints with a pelvic belt are used in consequence of the rotation of the knee and hip (see Fig. 902, page 879). During the entire time active and passive movements, massage, and electricity are employed. The patient is not to be regarded as cured until he can walk and stand on the entire sole and with the end of the foot abducted.

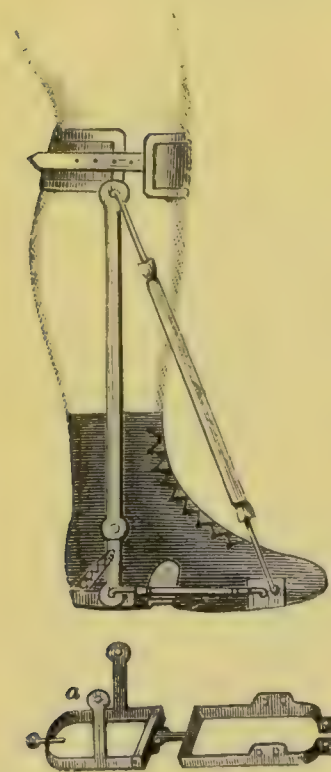


FIG. 914.—Sayre's shoe for clubfoot with an iron sole piece (a) and elastic traction.

Operative treatment is indicated in severe cases of clubfoot of long standing. Numerous operations have been recommended, including linear or cuneiform osteotomy on the dorsum and the outer side of the tarsus (Weber 1866, Davis Colley 1877), excision of the astragalus (Lund 1872), excision of the cuboid (Little 1854, Jolly 1857), excision of several tarsal bones (the astragalus, the cuboid, the scaphoid, West 1878), cuneiform resection of the neck of the astragalus (Hueter 1877), resection of the ankle joint (see page 895 ff.), linear osteotomy of the tibia and fibula close above the ankle joint (E. Hahn 1881),

and, finally, Phelps's operation. Meusel, after exposing the neck of the astragalus, removed simply its bony nucleus with a small periosteal elevator, and thus secured very good results. The rest of the astragalus was left and the joints were not opened. After the bony nucleus of the astragalus had been removed, the foot was easily brought into a normal position and the result was very satisfactory.

Phelps's Operation consists in putting on the stretch the soft parts (skin, fascia, tendons) on the inner side of the foot and then dividing them. The wound, which is left open, is dressed antiseptically, and a plaster-of-Paris splint is applied over the antiseptic dressing. I perform the operation only in severe cases, especially among older children. The subcutaneous rupture of the soft parts by *brisement forcé* is simpler.

Vincent recommends for severe cases supramalleolar osteoclasis, so as to allow outward rotation of the tip of the foot.

Excision of the Astragalus (see page 864) is, to be sure, a very disturbing operation, as far as the ankle joint is concerned, but its results are favourable (Ried, Rupprecht, Panzeri), and, inasmuch as the operation

is performed, as a rule, only in cases of long standing, the injury to the ankle joint need not be considered. On the contrary, the patient's ability to walk is much improved. If an operation is necessary, I should either remove the astragalus or perform cuneiform osteotomy on the outer side of the tarsus. The removal of the astragalus by means of a longitudinal incision over it and the subsequent straightening of the foot are much facilitated by first resecting, according to Ried's suggestion, half a centimetre to a centimetre from the tip of the external malleolus. Bergmann and Bessel-Hagen recommend division of the middle fasciculus of the external lateral ligament instead of resection of the external malleolus after extirpation of the astragalus. In all these operations I leave the wound open, after the foot has been straightened, and immediately apply a plaster-of-Paris splint over the antiseptic dressing.

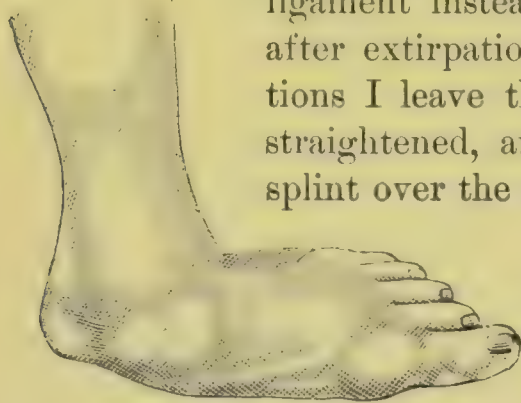


FIG. 915.—Pes valgus (flat foot).

The treatment of acquired clubfoot is directed above all against the cause (paralysis, cicatrices, unreduced dislocation). In other respects it is the same as just described. In case of a paralytic loose joint, resection of the

ankle, extirpation of the astragalus, or arthrodesis, with or without extirpation of the astragalus, are to be recommended. In suitable cases the tendon of a paralyzed muscle may be united to a non-paralyzed one, and in this way the position and function of the foot improved.

§ 366. **Pes Valgus (Flat Foot).**—Pes valgus (Fig. 915) is the opposite of clubfoot—that is, it is a pronation contracture. It is sometimes congenital, but is much more frequently acquired. Flat foot is strikingly common in many regions and among certain races—e. g., Jews and negroes. According to the reports of military surgeons, flat foot is very prevalent in Schleswig-Holstein, for example.

Origin of Congenital Flat Foot.—Abnormal conditions of pressure on the foetus and abnormal position of the same, in consequence of lack of space in the uterus, play an important part also in the development of congenital pes valgus, as has been proved especially by Volkmann and Küstner. Pes calcaneo-valgus is the most common—that is, a valgus position with decided dorsal flexion of the foot (Fig. 904, page 881). We likewise mentioned, on page 884, Volkmann's interesting observation of a case in which pes varus had developed on one side and pes valgus on the other, in consequence of lack of space with compression of the feet (see Fig. 908). A slight degree of flat foot is rather frequent, according to Küstner, among infants, about 8.6 per cent of them being thus affected. These mild forms of pes valgus, however, are of great practical importance in so far as they become

more marked later, when the children walk, in consequence of the weight of the body, and these cases should, no doubt, be included in part among those that are congenital. Such children are often rhachitic (rhachitic pes valgus). Among other causes of congenital pes valgus are absence or rudimentary development of the fibula (Wagstaffe and others), synostosis between the os calcis and the scaphoid (Holl), and congenital paralysis resulting from some congenital anomaly of the central nervous system. Hereditary pes valgus has repeatedly been observed.

The anatomical changes in congenital pes valgus consist, as in clubfoot, in an alteration in the shape of the bones and the positions of the joints, due to the continued pronation. Here also, as in congenital pes varus, the astragalus and os calcis show the greatest amount of change, which is precisely the opposite of that observed in clubfoot (see page 884).

The treatment of congenital flat foot conforms to the same general principles as that of pes varus. It consists in forcible correction of the deformity as soon as possible after birth and in fixation of the foot by means of removable splint bandages as recommended by König, Volkmann, and others. Active and passive movements and massage are of the greatest importance here also. Gutta-percha or plastic felt are utilized as materials for splints. The splint, which is made pliable by warming it in hot water, is fitted to the extremity, which is bandaged as far as the knee with wet gauze or mull. It is secured with a wet bandage, with the foot in an overcorrected posture (in supination and plantar flexion). The hardening process may be hastened by pouring on cold water. The splint which has been fitted to the extremity is then removed, its edges are smoothed, the leg is padded with a little wadding or flannel, and the splint is secured by means of bandages or adhesive plaster.

Acquired Flat Foot.—The flat foot that occurs in the first years of childhood, especially in connection with rhachitis, is congenital, no doubt, in a portion of the cases. Pes valgus also occurs in weakly individuals at the age of puberty in consequence of supporting the weight of the body for prolonged periods—e. g., among waiters, factory girls, bakers, locksmiths' apprentices, etc. A late form of rhachitis is often present here also. The inner border of the foot is depressed in consequence of its continued support of the body, the arch of the foot is brought into pronation, or, more correctly, according to Meyer, the arch of the foot tips over to one side and the sole is correspondingly flattened. The most important agency in the development of pes valgus after birth is the abnormal softness (rhachitis) of the tarsal bones at the time of puberty as well as in the earliest years of childhood. The abnormally soft growing bones undergo a corresponding change in form from the pressure of the weight of the body, the joints are dis-

placed, and the pes valgus—that is, the pronated position of the foot—becomes more and more fixed, as we saw in connection with pes varus. The growth of the anterior process of the os calcis, which supports most of its weight, is restricted, especially in height, while the sustentaculum tali, on the contrary, stands very high—that is, the inner border of the foot is abnormally depressed and the outer border abnormally elevated. The range of pronation has increased at the expense of the inhibited supination. The astragalus has lost its character as keystone of the arch of the foot, and, contrary to the normal order of things, the sagittal diameter of its upper surface is diminished while that of the lower surface has increased. According to Henke, to whom we are indebted for a thorough knowledge of pes valgus, not only are the two astragalo-tarsal joints displaced, answering to the increased pronation, but the ankle joint also is involved. The ankle joint is in plantar flexion because the anterior surface of the astragalus is depressed.

The development of flat foot is also largely aided by the tiring of the tibialis posticus muscle and the small muscles of the sole of the foot resulting from continued walking and standing, whereupon the remaining soft parts—the ligaments and the plantar fascia—are more likely to yield, which, with the tibialis posticus muscle and the short muscles of the sole, support the arch of the foot. Flat foot is not infrequently associated with varicose veins and sweating feet. The disturbed circulation in varicose veins and sweating feet is thought by some to cause atrophy of the muscles of the sole of the feet, and in this way to bring about a gradual flattening of the arch. In my opinion, there is still to be added a very essential factor, which has not as yet been emphasized—viz., the bending, much as in genu valgum, of the lower epiphysis of the tibia, in consequence of rhachitis. The shaft of the tibia rests obliquely on the epiphysis. This fact is also of importance as regards the treatment.

Symptoms of Flat Foot.—In case of pes valgus in the first years of childhood the child complains especially of slight fatigue and of pain in the feet, and he often limps in walking. The deformity is distinctly seen especially when the child walks and stands—that is, it is noticeable that the inner border of the foot is depressed under the pressure exerted by the weight of the body and that the patient plants his foot more broadly than is normal. Symptoms of rhachitis are usually demonstrable in connection with pes valgus in the first years of childhood.

Essentially the same symptoms (pain and slight fatigue) are observed in pes valgus at the age of puberty and among adults. In order to ascertain approximately the degree of the flattening of the

sole of the foot, the latter is besmeared with black and then placed upon white paper or immersed in water and planted upon the floor. Under normal conditions the more elevated inner border does not touch the floor in standing and walking, while in case of flat foot the whole surface of the sole, including the inner border, makes an imprint upon the floor. In case of flat foot among adults, the foot is broader, the internal malleolus is lower and the external malleolus higher, and approximated to the lateral surface of the obliquely situated os calcis. Hueter observed a sort of secondary calcaneo-fibular joint. The amount of disturbance attending flat foot at the age of puberty and among adults is very variable. The discomfort is sometimes very slight or it may be absent altogether, giving the patient, at most, a less elastic gait or causing him to tire easily.

Not infrequently, however, severe pain occurs in the tarsus, coming more or less suddenly or gradually increasing in severity, so that the patient's activity is completely interfered with—that is, the so-called inflammatory flat foot ensues. We have here to do, not with inflammatory symptoms in the ordinary sense, but only with severe pain in the tarsus. The pain is felt mainly at three places: 1. At the inner border of the foot over the tuberosity of the scaphoid and in the direction of the sole of the foot, answering to the tensely stretched calcaneo-scaphoid ligament and the head of the astragalus, which is being forced downward. 2. About in the middle of the dorsum of the foot, where the scaphoid and the remainder of the anterior portion of the foot press against the head of the astragalus. 3. Over the anterior process of the os calcis, in front of the external malleolus, caused by the pressure of the edge of the body of the astragalus, which is pronated. The region of the heel also and the metatarso-phalangeal joints are often painful (Lücke). The foot becomes more and more immovable in the further course of inflammatory flat foot, and more and more fixed in extreme pronation, so that ankylosis in the astragalo-tarsal joints is suggested. In addition to this, the patient tries by spasmodic contractions of the muscles to prevent attempts at passive motion on the part of the examining physician, especially supination, on account of the pain caused thereby. There is sometimes swelling of the foot, but not always. Inflammatory flat foot is a common malady, and is often confounded with rheumatic arthritis.

Inflammatory flat foot is, as has been said, not an inflammation proper, but denotes an increased painfulness of the stretched ligaments, fasciæ, and other soft parts, as well as of the bones, which are compressed and sometimes eroded in consequence of the pressure. This is the result of overexertion and other mechanical causes. In order

to relieve the pain that attends movement of the foot, the patient involuntarily fixes the latter in the position that gives the freest possible range of movement—i. e., pronation.

Treatment of Flat Foot.—In cases of rhachitic pes valgus among children the patient should, above all, wear a laced boot with an internal splint jointed at the ankle and reaching to the knee joint. This should tend to supinate the foot. The growth of the bones is favourably influenced by the supination. The existing rhachitis is also to be overcome by brine baths, preparations of lime, care for good air and suitable nourishment (see Principles of Surgery, page 643). Forcible straightening, as in clubfoot, is to be recommended in suitable cases, with the subsequent use of a portable water-glass splint, which is kept on for some time, or, better, use is made of removable splints and frequent massage. Essentially the same treatment is to be recommended also for pes valgus at the age of puberty. Here also an internal splint inducing supination is attached to the laced boot. Combined with this, a metallic, cork, leather, or India-rubber sole for elevating the inner side of the foot, with or without the action of an elastic spring, may be inserted so as to force the foot into supination. In mild cases this supporting sole or pad in the shoe on the inner side of its sole (Fig. 916) is sufficient. I must acknowledge, however, that I have not seen much benefit in the treatment of flat foot from inserting pads. They are not, as a rule, endured permanently. The shape of the shoe worn by persons with flat foot is very important. The best thing is a laced boot with a broad and high heel which extends well forward—e. g., to the joint between the os calcis and the cuboid (Lorenz, Meyer, and others). The sole should be raised on the inner side. Massage of the foot and of the muscles of the leg is very serviceable at every age.

Massage with active and passive movements, especially supination, has an excellent and often a magical effect in pronounced cases of inflammatory flat foot. I have altogether given up the use of a plaster-of-Paris splint with the foot in supination. It may be necessary at the first attempt at massage and passive movement of the fixed and apparently ankylosed foot to use an anæsthetic. Lorenz recommends the injection of cocaine into the astragalo-scaphoid joint and the application of a plaster-of-Paris splint in inflammatory (spastic) flat foot, a treatment which Motta also approves.

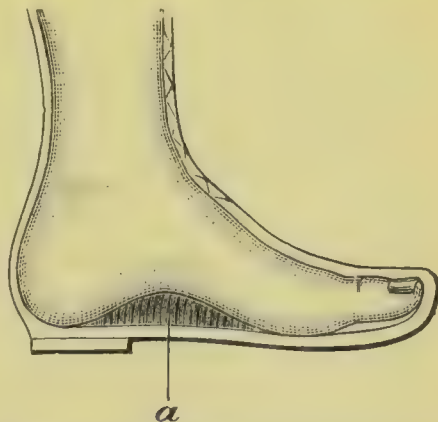


FIG. 916.—Pad under the arch of the foot for pes valgus.

Ogston recommends for severe cases of flat foot the formation of a synostosis between the astragalus and scaphoid by resection of the astragalo-scaphoid joint. After the joint has been exposed by a longitudinal incision the head of the astragalus is chiselled away and enough of the scaphoid is removed to overcome the deformity as far as possible. The resected bones are united by means of two ivory pegs. A plaster-of-Paris splint is applied over the antiseptic dressing, and after three months of rest in bed the foot should be ready for use again. The results, according to Ogston, are very favourable. I am disposed, with König, to doubt whether this operation is a rational one from the point of view of the etiology of flat foot. Weinlechner extirpated the astragalus with very good results, and Kirmisson the scaphoid.

Linear osteotomy of the tibia and fibula just above the ankle joint is a thoroughly rational operation in case of the above-mentioned rhachitic bending of the shaft of the tibia. The foot is immobilized in its corrected position, by means of a plaster-of-Paris splint, for about five weeks after the operation. Such is the success in favourable cases that the normal arch of the foot develops again after the operation. Several surgeons have obtained good results by this method. The deformity may also be corrected by using Lorenz's osteoclast.

§ 367. **Tumours of the Foot.**—All the common tumours occur on the foot—e. g., among those of the connective-tissue type, the lipoma, fibroma, neuro-fibroma, angioma, and sarcoma. The neuro-fibroma is characterized by severe pain. It develops most commonly in the subcutaneous nerves of the dorsum of the foot. The melanotic sarcoma is very common, but the reason of this is not known. The frequency of melanotic sarcoma on the foot is second only to its frequency in the choroid membrane. Small melanotic sarcomata often appear in rapid succession on the foot, the leg, the thigh, and in the internal organs. The primary tumour on the foot may still be small, and yet the patient be doomed, in consequence of numerous metastases in the internal organs.

Chondromata and osteomata, as well as their mixed forms, occasionally occur on the bones of the foot and the toes, but by no means so frequently as on the hand. Exostoses sometimes develop alongside of or beneath the nail of the great toe, especially in young persons. They originate in most cases from the epiphyseal cartilage. The nail is correspondingly elevated by the tumour, which is of the size of a cherry stone or a hazelnut. After the osteoma has been exposed, its base is removed with a chisel or a bone-cutting forceps.

Among epithelial tumours there occur especially sebaceous cysts, papillomata (warts), and epitheliomata, the latter, for example, in the

region of the heel, on the dorsum of the foot, and on the toes. The inguinal glands not infrequently become involved very early in case of epithelioma, for which reason active measures must be adopted at once, involving, it may be, amputation of the leg. The papillary growths attending lupus (tuberculosis) and syphilis (condylomata, see page 870) are carefully to be distinguished from warts. Among other benign epithelial growths the circumscribed and diffuse callosities and corns, which we have already mentioned on page 872, may be included. The treatment of tumours of the foot follows general rules.

Ganglia of the Foot.—The ganglia of the foot which originate from a joint, a tendon sheath, or a bursa may be mentioned here, although they do not belong to the tumours proper. They form here also, as upon the wrist joint and the hand, characteristic hard or softer nodules. Ganglia that originate from a joint can be emptied partially or completely if they are still in open communication with the joint in question. In other cases they are completely shut off from the joint and can no longer be emptied by pressure. Ganglia which are apparently shut off from the joint sometimes communicate with it by a very small opening. This is important to remember in operating on them. Ganglia on the foot are sometimes as large as a hen's egg, so that the shoe has to be made especially to receive them. The best treatment of ganglia consists here also in excision under the strictest aseptic methods, as one must be prepared to find a small communication with the ankle or a tarsal joint, even though the ganglion be apparently shut off.

Hygromata of the bursæ are observed especially at the posterior and anterior ends of the metatarsal bone of the great toe, resulting from the pressure of the boot, particularly, as has been said, in connection with hallux valgus (see pages 875, 876). They are sometimes combined with proliferation of the periosteum. They are treated by opening them and excising the sac as completely as possible. The periosteal outgrowths, or osteomata, are removed with hammer and chisel.

§ 368. **Resection of the Ankle Joint.**—The methods for the resection of the ankle joint are numerous, thirty-five different ways of performing the operation being known at the present time. Langenbeck's method, by means of two lateral incisions (Fig. 917), is still in general use for traumatic cases, especially for cases arising in military surgical practice. The results secured by this method, especially when the foot is left ankylosed at right angles, without supination or pronation, are excellent. One patient operated upon by Langenbeck ascended Mont Blanc. The methods of König, Ollier, and Lauenstein, and also those of Vogt, Réverdin, Kocher, and Tiling, are especially adapted for resection of the ankle joint on account of tuberculosis, all of which afford a better inspection of the diseased joint and a complete excision of the diseased synovial membrane. Extensive atypical resections—

e. g., of the ankle joint and the tarsus (Kappeler), Pirogoff's amputation, Mikulicz-Wladimirow's osteoplastic operation or their substitutes (see pages 903-912), or, finally, amputation of the leg—are indicated in the worst cases of tuberculosis of the ankle joint and the tarsal bones.

Subperiosteal Resection of the Ankle Joint, after Langenbeck.—A longitudinal incision about six centimetres long is made along the posterior border of the end of the fibula, with the foot resting upon its inner side. At the tip of the external malleolus this incision curves upward,



FIG. 917.—Langenbeck's method of resection of the ankle by the use of a lateral incision over the end of the fibula (*a*) and the tibia (*b*).

corresponding to the anterior border of the fibula (Fig. 917). The incision is made down to the bone. The periosteum is detached on all sides from the fibula with a periosteal elevator, but retains its connection with the skin and the remaining soft parts (tendon sheaths, muscles). Care is to be taken in doing this that the periosteum remains connected, as far as possible, with the interosseous membrane, as the latter is likewise important for the new growth of bone. The lower end of the fibula is then divided at the upper end of the incision with a metacarpal saw or a chain saw or with hammer and chisel. The lower fragment of the fibula is then seized with bone forceps, and the three fasciculi of the external lateral ligament are severed close to the malleolus, care being taken not to wound the important structures in the vicinity.

The foot is now turned over upon its outer side and the so-called anchor incision is made over the lower end of the tibia (Fig. 917, *b*). The longitudinal incision, which is about five centimetres long, runs down the middle of the tibia, and the curved incision, which is from three to four centimetres long, corresponds to the lower border of the internal malleolus. Both incisions are made down to the bone. The periosteum, in connection with the skin and the remaining soft parts, is detached along these incisions with the periosteal elevator or by the occasional use of the hammer and chisel. Great care is taken not to wound the flexor and extensor tendons. After division of the internal lateral ligament at its attachment to the lower end of the tibia,

the foot can be turned outward, so as to permit a good inspection of the joint. The lower end of the tibia, having been exposed on all sides, is now divided with a metacarpal or a chain saw or with the chisel. Here also, as on the fibula, preservation of the interosseous membrane is of the greatest importance for the regeneration of the bone, and it is raised from the inner surface of the tibia, together with the periosteum. After the anterior and posterior insertions of the capsule upon the tibia have been divided, whereby the tendon of the tibialis posticus muscle must be protected, the resected end of the tibia is removed. If it is desired to remove the upper articular surface of the astragalus, it is done with the metacarpal saw, from in front backward, or with the chisel, or, in case of caries, with a sharp spoon. Then follow arrest of the hæmorrhage, drainage (posteriorly between the fibula and the tendo Achillis), disinfection of the wound with 1-to-1,000 bichloride, suture, the application of an aseptic dressing, and elevation of the foot upon a Volkmann splint, with the ankle joint exactly at right angles, or upon an extension apparatus—e. g., as represented in Figs. 891 or 892, page 859. If the wound runs an aseptic course, a plaster-of-Paris splint is applied over the antiseptic dressing after the removal of the drainage on the third or fourth day, and this is kept on, it may be, until the wound has healed.

During the after-treatment care must be taken that the foot remains at right angles with the leg, without supination or pronation. As ankylosis of the ankle joint gives the best functional results, passive movements are to be omitted after the wound has healed. It is a good plan for the patient to wear for a time a laced boot reaching to the knee, with two lateral splints.

The other methods of resection of the ankle joint are suited especially for “pathological” resections—that is, in particular, for tuberculosis of the joint. They aim, above all, to secure a thorough exposure and inspection of the joint, in order that it may be possible to remove completely the diseased synovial membrane. I mention particularly the following methods:

König's method, which is a very good one, is performed as follows: The inner longitudinal incision begins three centimetres above the joint, runs over the anterior border of the internal malleolus and over the neck of the astragalus to the articulation between the astragalus and the scaphoid. The outer incision, which has the same length as the inner one, is carried downward over the anterior border of the external malleolus. Both incisions enter the joint. The soft parts in front, with the synovial membrane, are raised from the bone with a periosteal elevator and a knife. The anterior diseased portion of the synovial membrane can be excised at once, and any tubercular focus in the bone scraped out. Then follows the second

part of the operation, which consists in resection of the bones and excision of the synovial membrane in the following manner: The outer cortical layer

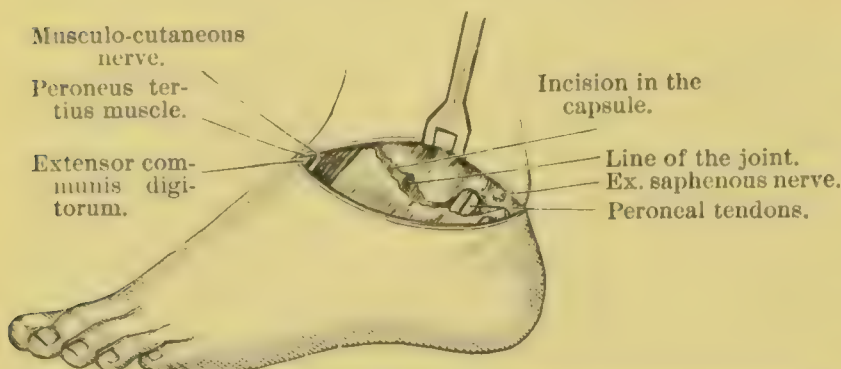


FIG. 918.—Resection of the ankle after Réverdin and Kocher.

of each malleolus is chiselled away from in front and remains connected with the soft parts; the articular surface of the tibia is chiselled away with a broad chisel and removed with a periosteal elevator and bone-cutting forceps. A disk of bone is removed in the

same way from the articular surface of the astragalus, and in case of extensive disease the astragalus is extirpated. Then follow thorough excision of the synovial membrane, drainage, disinfection, and suture of the wound. The after-treatment is the same as above.

P. Bruns modified König's method for arthrectomy (synovectomy) in that he chisels away only the articular surfaces of the malleoli after making König's longitudinal incisions. He then makes one or two longitudinal incisions on the posterior and outer border of the tendo Achillis, excises the synovial membrane from in front and behind, with removal, it may be, of diseased portions of bone, and sutures the anterior and drains the posterior incisions.

Kocher and Réverdin employ an external incision and turn the joint surfaces outward (Figs. 918 and 919). This external incision begins between the tendo Achillis and the external malleolus and then runs around the tip of the latter to the extensor

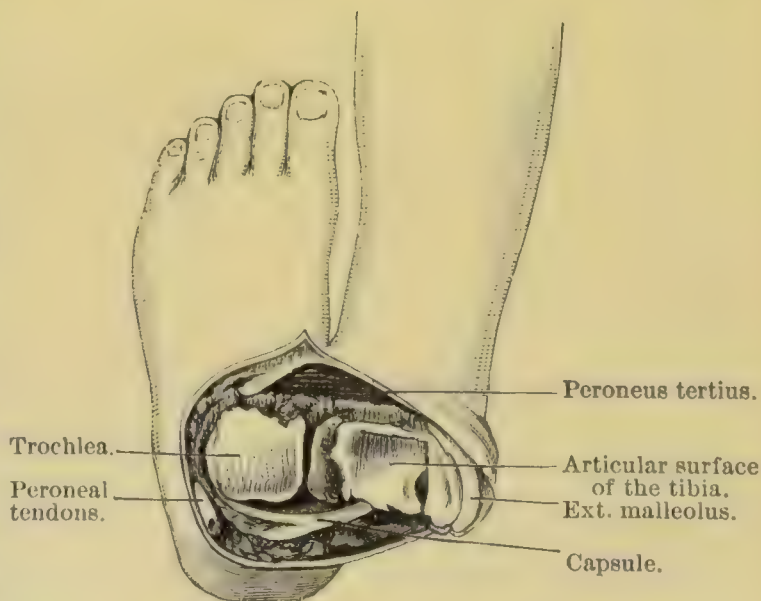


FIG. 919.—Resection of the ankle after Réverdin and Kocher. The articular surfaces brought into view.

tendons. The tendons of the peronei muscles are detached from the groove behind the external malleolus and drawn backward and downward. The ligaments attached to the tip of the external malleolus having been severed or the latter chiselled through, the astragalus and the interior of the joint, with the exception of the portion between the internal malleolus and the astragalus, are now easily accessible between the peroneal and extensor tendons, which are suitably retracted. If necessary, the astragalus may

be removed, and this allows a perfect inspection of the interior of the joint.

Serr describes the following method of arthrectomy (synovectomy) of the ankle joint for children, by means of which normally movable joints were secured in four cases of tuberculosis: The method is based upon that of Kocher. The skin incision, beginning over the peroneus tertius muscle, which is to be spared, traverses the external malleolus at the level of the ankle joint and extends to the tendo Achillis. Then follows the division of the subcutaneous cellular tissue and the subcutaneous fascia. The two peroneal tendons running behind the external malleolus are doubly tied with silk or catgut and severed between the ligatures. The joint is opened in front of and behind the external malleolus, the periosteum is divided longitudinally, and the malleolus is separated from the fibula in the line of the incision. The joint surfaces are then turned outward, with detachment of the capsule from the tibia in front and behind. After the capsule has been dissected out the foot is brought back into position, the peroneal tendons are sutured, the external malleolus reunited, etc.

Tilling recommends a double curved incision, for the purpose of making the portion of the joint between the astragalus and the internal malleolus more accessible—that is, he cuts a flap on each side with the base beneath the external and internal malleoli. The incision begins on each side somewhat below the line of the joint, alongside the extensor tendons, passes upward for a distance of two or three centimetres parallel to them, then runs in a curve to the posterior border of the fibula and the tibia, and finally ends on the same level with the beginning of the incision. The ankle joint is opened in front, the internal and then the external malleolus is chiselled through obliquely, with preservation of the tendons, and both flaps of soft parts and bone are reflected downward. If necessary, the astragalus is extirpated.

P. Vogt extirpates the astragalus in the first place, in the manner described on page 864, and then completes the resection by the removal of the diseased portions of the remaining bones and the synovial membrane. It is a good plan to add to the anterior incision a posterior one—e. g., along the outer border of the tendo Achillis.

Ollier and Iversen also recommend excision of the astragalus in performing resection or arthrectomy (synovectomy) of the ankle joint, so as to be able to remove thoroughly all that is diseased. Iversen makes use of a curved transverse incision similar to Hueter's, which is described below. Ollier makes an outer *Λ*-shaped incision over the inner border of the fibula and extending to the anterior border of the cuboid, and an inner *∟*-shaped incision from the anterior border of the tibia downward as far as the tuberosity of the scaphoid and encircling the internal malleolus. After removing the astragalus, Ollier scrapes out the surface of the tibia and the malleoli, and always strives to retain the form of the articular surface of the tibia. If it is found necessary to resect the lower end of the tibia, Ollier cuts out a new articular surface in the portion of the tibia that remains. He has secured excellent results, and I fully agree with him that the removal of the astragalus is to be recommended in case of tubercular disease of the bones.

Poulsen proposes placing the astragalus in sterilized salt solution while the operation lasts, and then returning it to its place after removing the synovial membrane of the joint.

F. Busch recommended a transverse plantar incision with temporary division of the os calcis; C. Hueter the anterior transverse incision from one

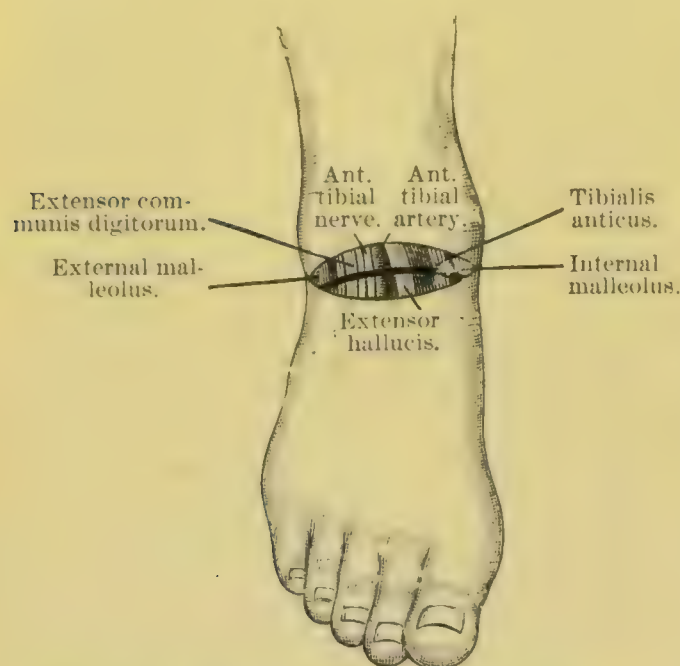


FIG. 920.—Resection of the ankle after Heyfelder, Sédillot, and Hueter.

malleolus to the other, after J. Heyfelder and Sédillot (Fig. 920). The dorsalis pedis artery is isolated and divided between two ligatures. The anterior tibial nerve is likewise exposed, tied in two places with catgut, which is kept long, and then divided. The tendons are likewise tied with long pieces of catgut before their division, in order that they may be sutured later. The joint is then opened. The cutaneous incision may be made farther downward over the tarsus, as in forming the dorsal flap in Bardenheuer's resection of the tarsus (see page 902). I have operated three times by Hueter's method,

with very good results. The method does not involve as much injury of the soft parts as it would seem. The view of the joint which is afforded is excellent. The fear that gangrene or neuralgia may result seems to me unfounded.

Lauenstein has recommended the following method (see Fig. 921): A longitudinal incision (through the skin only) is made over the middle of the fibula, beginning where it projects between the peroneus brevis and peroneus tertius muscle, extending to the tip of the external malleolus and then continuing forward, with a slight curve, to the level of the astragalo-scapoid joint over the heads of the extensor brevis digitorum muscle and behind the tendon of the peroneus tertius. The skin is dissected up anteriorly and posteriorly, the fascia on the anterior border of the fibula is divided, the ankle joint is opened in front of the external malleolus, the extensor tendons are lifted from the anterior surface of the tibia and fibula with a blunt retractor, the crucial ligament is severed, and the anterior insertion of the capsule on the tibia and fibula is separated to a point beyond the middle of the tibia. The fascia is then divided on the posterior border of the fibula, the sheath of the peroneal tendons is opened, and the latter, as well as the remaining muscles on the posterior aspect of the fibula and tibia (flexor longus pollicis), are drawn backward with a blunt retractor, in order that the external lateral ligament may be severed with a small knife parallel to the inner surface of the external malleolus. The ankle joint can now easily be laid open by supination of the anterior portion of the foot (Fig. 922).

§369.] RESECTION OF THE TARSUS, METATARSUS, AND TOES. 901

Under the designation of a resectio-tibio-calcanea Bruns describes the following operation, which he performed with good results in cases of tubercular disease of the tibia and fibula, the talus and the os calcis: The ankle

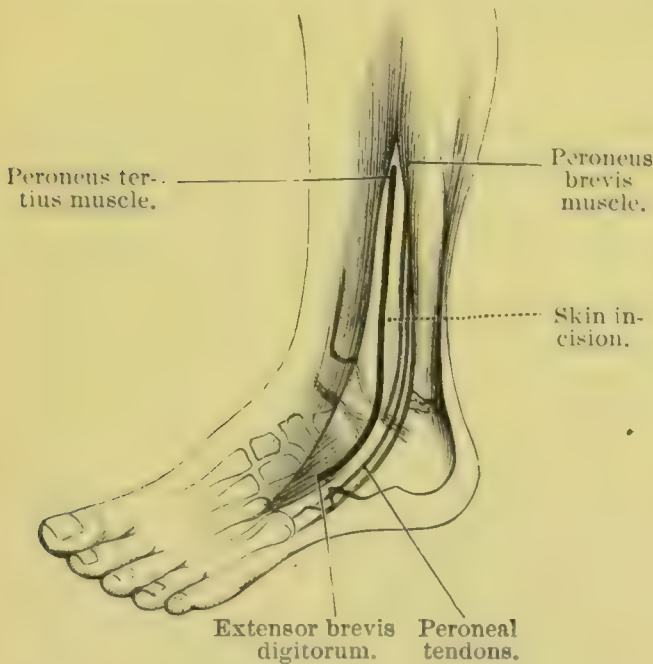


FIG. 921.—Resection of the ankle after Lauenstein.

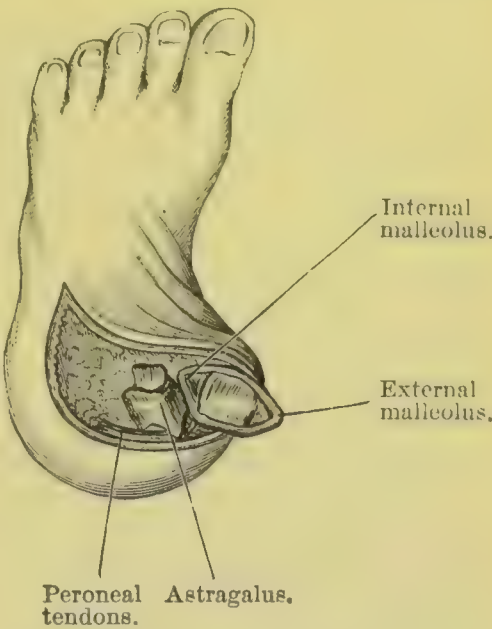


FIG. 922.—Resection of the ankle after Lauenstein.

joint is opened by a curved incision over the dorsum of the foot, the astragalus is extirpated, the articular surfaces of the tibia and fibula, as well as the upper surface of the os calcis, are sawn off in a horizontal direction, and the sawn surfaces of the os calcis and the bones of the leg are fitted together and nailed.

In the resection of the astragalo-calcaneal joint by Bogdanik's method the skin incision runs from one malleolus to the other over the tip of the tuberosity of the os calcis, and the latter is sawn through from behind and reflected. The further course of the operation depends upon what is found in each case to be the condition of the joint.

Resections of the ankle have been followed in some cases by neuralgic pains of more or less severity, due, for example, to injury of nerves during the operation, to the attachment of the swollen ends of a nerve to the bone, to pressure of the edge of the tibia against the anterior tibial nerve, to a neuroma, etc. (Braun, Obalinski, Witzel). To prevent such neuralgia after amputations the nerves should be drawn out of the wound and cut off high up.

Arthrodesis—i. e., the formation of an artificial ankylosis of the ankle joint on account of a loose joint or an old or acquired pes varus—is performed in the way described on page 535. This operation has been performed on the ankle a great many times and with excellent results. Out of forty-four cases of infantile spinal paralysis for which arthrodesis was performed, the result in twenty-three cases was good, in nineteen satisfactory, and in two bad.

§ 369. **Resection of the Tarsus, the Metatarsus, and the Toes.**—Among resections of the individual tarsal bones the resection and extirpation of

the astragalus and the os calcis are especially to be considered. These we have already described on pages 864 and 865. The resection or extirpation of the cuboid and the three cuneiform bones requires no special description. In case of tubercular disease or traumatic suppuration of the small tarsal bones that have been named, and of the bases of the metatarsal bones, Bardenheuer's method may be used. A transverse incision is made through all the soft parts of the dorsum of the foot, from the base of the first to the base of the fifth metatarsal bone, and a longitudinal incision on the inner and outer border of the foot reaching backward to a point beyond the proximal limit of the disease. The dorsal flap of soft parts is dissected up from the bone, and the diseased portion of the latter is divided where the bone is sound (not through the joints), with the saw or with hammer and chisel, and detached from the soft parts of the sole of the foot. The wound is packed, and after it has begun to granulate the anterior portion of the foot is united with the posterior portion by secondary suture of the freshened edges of the skin. In suitable cases the wound is drained and sutured at once. Suture of the tendons is unnecessary. One must be especially on his guard, as the healing goes on, against the development of flat foot.

A longitudinal incision may also be made in the sole of the foot as far as the heel or beyond this, and the astragalus, os calcis, scaphoid, and cuboid excised or scraped out (Félizet). Obalinski, in resecting the tarsus, uses a longitudinal incision between the third and fourth toes.

Osteoplastic Resection of the Tarsus by the Mikulicz-Wladimirow Method is of great value in treating gunshot wounds, as well as extensive tubercular disease of the tarsus and ulcerative destruction of the heel, where amputation of the leg was formerly resorted to. The operation has also been performed with satisfactory results in cases of paralytic pes equinus and for lengthening the leg after resection of the knee, etc. It was first performed by Wladimirow (Kasan) in 1871, but remained altogether unknown in Germany. Mikulicz devised the operation anew in 1880, and performed it in a case of syphilitic ulcer of the heel. The ankle joint is removed with the astragalus, the os calcis, and the posterior half of the scaphoid and the cuboid (Fig. 923, 1), and the anterior portion of the foot is united, in an equinus position, with the sawn surfaces of the tibia and fibula (Fig. 923, 2). The operation is performed as follows:

The patient lies upon his abdomen and the operator faces the sole of the foot. An Esmarch bandage is employed. A transverse incision is first made across the sole, beginning one centimetre behind the tuberosity of the fifth metatarsal bone, and ending in front of the

tuberosity of the scaphoid. An incision running obliquely upward and backward to the posterior borders of the two malleoli is then made from each of the ends of this transverse incision, and the ends of these two lateral incisions are united by a transverse incision over the posterior aspect of the bones of the leg, with division of the tendo Achillis. All four incisions are made down to the bone.

The foot being sharply flexed, the ankle joint is opened from behind, and, after the lateral ligaments have been severed, the astragalus and os calcis are enucleated from the soft parts by means of cuts directed constantly against the bone. Thin disks of bone are then sawn from the articular surfaces of the bones

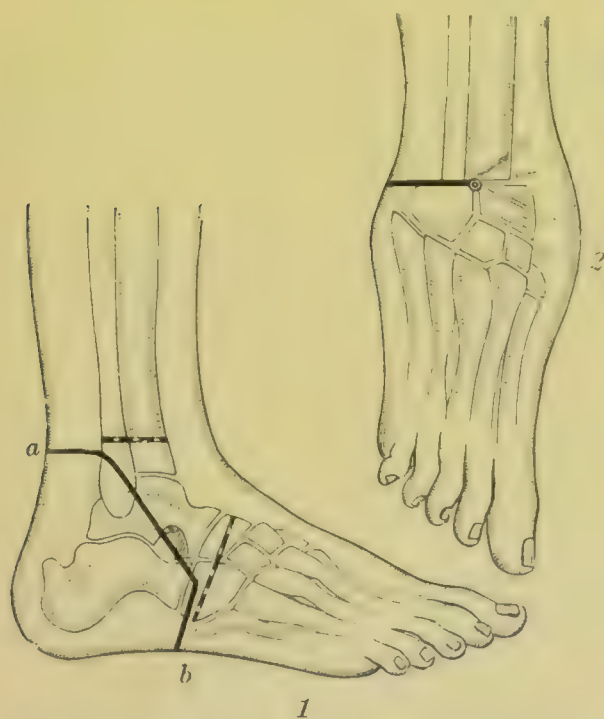


FIG. 923.—Mikulicz-Wladimirow's osteoplastic resection of the tarsus: 1, incision through the soft parts (*a b*) and division of the bone; 2, position of the foot after the operation.

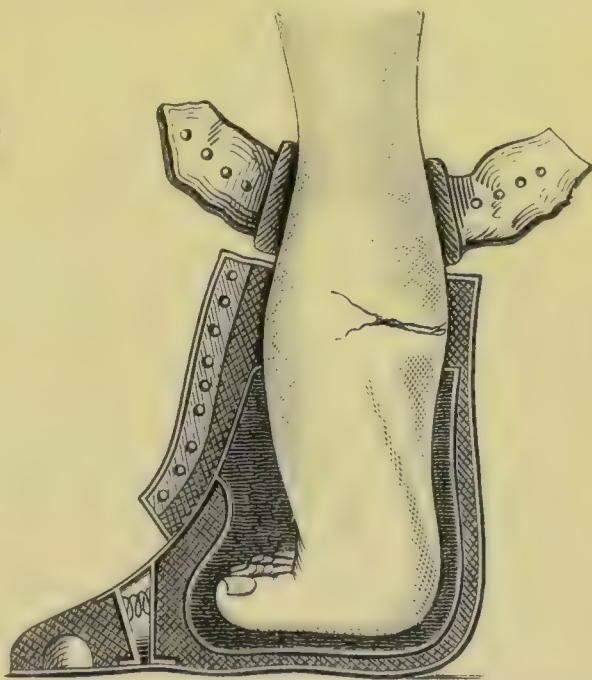


FIG. 924.—Final result after osteoplastic resection of the tarsus.

of the leg, which are now exposed in the wound, as well as from those of the scaphoid and cuboid. Then follow arrest of the hæmorrhage (ligation of the posterior tibial artery, between the tibia and the tendo Achillis, and of the external and internal plantar arteries, under the tarsal bones that are left) and coaptation and suture of the anterior portion of the foot, which hangs by the dorsal bridge of soft parts, to the sawn surface of the bones of the leg. The tendons of the plantar flexors are divided subcutaneously, in order that the toes may assume a right-angled dorsal flexion. The wound is then sutured. The soft parts usually form a thick prominence upon the dorsal surface of the bridge of soft parts. A few lead-plate sutures are applied through this, in order that the sawn surfaces of the bones may not be forced apart.

The patient afterward walks very satisfactorily upon the heads of the metatarsal bones and upon the balls of the toes, which are in sharp dorsal flexion (Fig. 924), as appears also from the statistics of Zesas, which cover twenty-four cases. In his first case Mikulicz secured a lengthening of the leg operated upon amounting to one and a half centimetres. In case of disease of the scaphoid, the sawn surfaces of the three cuneiform bones and the cuboid may be united with the bones of the leg. Kümmel extended the resection as far as the metatarsal bones and higher up upon the leg, and secured, with shortening of six centimetres, an otherwise satisfactory result.

Of late Mikulicz has employed the operation with success for large ulcers in the lower third of the leg and for ankylosis of the ankle joint. He modifies it by retaining the skin covering the back and sole of the heel, which usually goes to waste, and utilizing it for covering the defect in the soft parts of the leg.

Paul Berger modified the Mikulicz-Wladimirow operation in that he divided the soft parts only on the outer side of the ankle joint by means of a T-incision and performed the resection from here. In this way the posterior tibial artery and nerve are not severed.

Michaux recommends the following modification of the Wladimirow-Mikulicz osteoplastic operation: The incision begins at the outer border of the tendo Achillis, close beside its insertion on the os calcis, passes horizontally under the external malleolus and obliquely over the dorsum of the foot toward the articulation between the scaphoid and the cuneiform bones, to a point somewhat to the outer side of the tendon of the extensor longus hallucis muscle, then passes outward at an acute angle toward the tuberosity of the fifth metatarsal bone, dividing all the soft parts a little behind the articular line between the tarsus and the metatarsus, and then turns back to the starting point along the outer border of the foot. The sheaths of the extensor communis digitorum and of the peroneal tendons are opened, and all the soft parts on the outer dorsal surface of the os calcis and the cuboid are extirpated with the framework of bone. Resection of the bones then follows, and in such a way that the anterior section with the saw removes the bases of the metatarsal bones parallel to Lisfranc's joint. The metatarsal bones are sutured at an obtuse angle with the leg, so that the patient walks more upon the sole than upon the toes.

Kümmel used the following method in operating upon caries of the tarsus as a substitute for the Mikulicz-Wladimirow operation, and from cosmetic considerations: The tarsal bones were excised, the tibia and fibula, from which a fragment two and a half centimetres long had been removed, were freshened in the form of a staircase, answering to the stump of the foot, and the latter was then sutured to the bones of the leg. In another case Kümmel made a movable connection between the metatarsal bones and the tibia and fibula.

Precisely the same methods are used in the partial and complete resections of the metatarsal bones, the metatarso-phalangeal joints and

the toes, as for those of the hands and the fingers, and the reader is therefore referred to page 672 ff. We have already mentioned on page 876 the resection of the metatarso-phalangeal joint of the great toe for hallux valgus. Arthrectomy (synovectomy) of the joint can also be performed very conveniently by Petersen's method, in which the joint is exposed by an incision through the web between the great toe and second toe, as near as possible to the former.

Extensive Atypical Resections of the Foot.—The extensive atypical resections of the foot, for which the main credit is due to Kappeler, can be divided into three groups: 1, Resection of the ankle joint and the tarsus; 2, resection of the tarsus; 3, resection of the tarsus and the metatarsus. Isler has tabulated one hundred and forty-five such operations by Kappeler and various other surgeons. Of these patients, fifteen, or 10·3 per cent, died. The mortality is smaller, then, than that attending amputation of the leg, which amounts, according to Schede, to fourteen per cent. The functional results are better among young persons than among those that are older. The astragalus and the os calcis were removed in nine cases with very good functional results. In two cases nothing remained of the bones of the foot except parts of the os calcis and the astragalus as well as the phalanges, and here also the functional result was very satisfactory. These atypical resections are decidedly preferable to amputation of the leg and other osteoplastic operations upon the foot, because the patients walk upon the sole. The Mikulicz operation has the preference only when there is extensive loss of tissue in the region of the heel.

§ 370. **Disarticulation and Amputation** of the toes are performed in precisely the same way as described for the fingers on page 672. If it is desired to disarticulate all the toes at the metatarso-phalangeal joints, a plantar and a dorsal flap of soft parts are formed and the joints are opened from the dorsum. The curved plantar incision runs, with all the toes in dorsal flexion, from the inner border of the metatarso-phalangeal joint of the great toe to the outer border of the corresponding joint of the little toe. The curved dorsal incision is made from the ends of the plantar incision over the bases of all the toes, the two curved incisions joining each other at an acute angle. The plantar as well as the dorsal incision extends forward between the toes as far as the middle of the web. Both flaps are dissected up, and the toes are then disarticulated singly. The sesamoid bones beneath the head of the first metatarsal bone are left behind. The heads of the metatarsal bones are sawn off if necessary—e. g., if the flap of soft parts is not long enough to cover them. The digital arteries between the metatarsal bones are tied or twisted.

Disarticulation of the great toe with its metatarsal bone is performed in the same manner as that of the thumb (see page 674, also Fig. 925). A small transverse incision over the metatarso-phalan-

geal joint is added to the racquette incision on account of the great breadth of the base of the first metatarsal bone. The joint named lies about two finger breadths' distant from the tuberosity of the scaphoid. The metatarsal bone is disarticulated, subperiosteally it may be, in the course of the racquette incision, with constant rotation about its axis in the opposite direction, and the tendons of the extensor and flexor longus hallucis are divided transversely at the joint.

The disarticulation also of the fifth toe at the metatarso-phalangeal joint is best performed by the racquette incision in precisely the same way as that of the great toe. The same is true of the other toes with their metatarsal bones (see page 675, *The Hand*).

The flap method is less advisable than the racquette incision. This also was described on page 674, in connection with disarticulation of

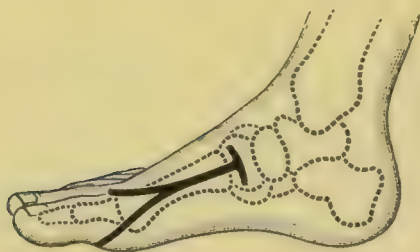


FIG. 925.—Disarticulation of the great toe with its metatarsal bone.



FIG. 926.—Disarticulation of the small toe with its metatarsal bone. Flap method.

the thumb. The flap method for the disarticulation of the great toe and the little toe at the metatarso-phalangeal joint is shown in Fig. 926—that is, all the soft parts between the two metatarsal bones are divided by sawing strokes, the little toe or the great toe with its metatarsal bone is abducted, and the metatarsal bone is excised from the flap of soft parts, answering to the second incision in Fig. 926.

Amputation of the metatarsus is usually performed by Jäger's method, with the formation of a long plantar and a short dorsal flap (Fig. 927, J).

The toes are brought into sharp dorsal flexion with the left hand, and a curved plantar incision is then made from one border of the foot to the other over the heads of the metatarsal bones. The semi-lunar flap containing all the soft parts is dissected up from the metatarsal bones to the place at which the amputation is to be made. A small dorsal flap is then formed from the soft parts of the dorsum of the foot. The soft parts at the reflection of the flaps are then divided by a circular sweep with the knife and the metatarsal bones are sawn through. The dorsalis pedis artery and the twelve or fourteen digital arteries are then tied.

Disarticulation of the Anterior Portion of the Foot at the Tarso-metatarsal Joint (Lisfranc's Operation, Fig. 927, L).—This operation is indicated when it is impossible to preserve any of the metatarsal bones. Its functional results are better than those attending Chopart's operation (Fig. 927, C), because the insertion of the tibialis anticus muscle on the tuberosity of the scaphoid is preserved. Lisfranc's operation is performed as follows:

The joint between the cuboid and the fifth metatarsal bone is felt for on the outer border of the foot, immediately behind the tuberosity of the fifth metatarsal bone, and that between the first cuneiform bone and the first metatarsal bone on the inner border of the foot. We mark these two points with the thumb and the forefinger of the left hand or by a small incision. The two points or the two incisions are then united on the dorsum by a slightly curved incision with its convexity directed forward or by an incision running somewhat obliquely. The small dorsal flap is dissected up from the subjacent parts and retracted

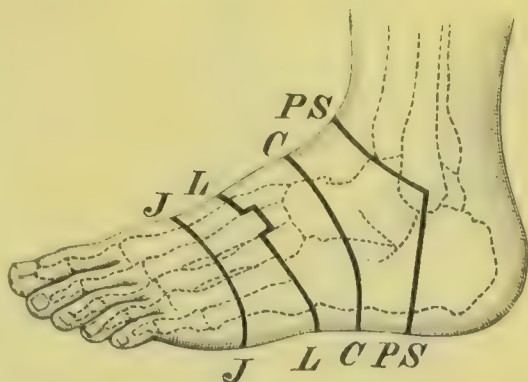


FIG. 927.—*J*, Jäger's amputation of the metatarsus; *L*, Lisfranc's amputation; *C*, Chopart's amputation; *P* and *S*, incision for Pirogoff's and Syme's amputations.



FIG. 928.—Lisfranc's joint.

by an assistant. The line of the tarso-metatarsal joints (Lisfranc's joint) is now divided with a narrow-pointed knife (Fig. 928). On the right foot the joint between the fifth metatarsal bone and the cuboid is opened first behind the tuberosity of the fifth metatarsal, the joint being made to gape by adduction of the anterior portion of the foot. On the left foot it is more convenient to begin with the first metatarso-tarsal joint. It is safer, however, for the inexperienced surgeon to begin with the fifth metatarso-tarsal joint on the left foot as well because the tuberosity of the fifth metatarsal bone is so easy to feel. The joint between the fourth metatarsal bone and the cuboid and that between the third metatarsal bone and the third cuneiform are now made to gape by plantar flexion of the metatarsus, and both are opened with the knife held transversely. The next joint between the second metatarsal bone and the second cuneiform lies farther back, and for this reason the joint between the first metatarsal bone

and the first cuneiform is opened next from the inside. The anterior portion of the foot is now sharply flexed and the second tarso-metatarsal



FIG. 929.—Küster's partial amputation of the metatarsus.

articulation is severed by passing the knife first backward to the line of the joint, then transversely through the joint, and finally forward again, dividing all the connections. All the joints being now completely opened, a large amputation knife is introduced behind the base of the metatarsal bones and a long plantar flap containing skin and muscle is cut with long sawing strokes close to the bone and extending as far as the heads of the metatarsal bones. Before the plantar flap is divided it is laid over the stump of the foot, to determine whether it has the necessary length. The dorsalis pedis artery is tied upon the dorsum of the foot, and the external and internal plantar arteries in the plantar flap.

In one case Küster disarticulated only the last four toes in Lisfranc's joint, preserving the first metatarsal bone with the great toe. As there was no skin for covering the wound surface, healing by granulation was necessary. The patient was a girl of four years, and the result was excellent. She was able to walk upon the head of the first metatarsal bone (see Fig. 929), and she could also dance and skate.

Chopart's Amputation.—In Chopart's amputation of the foot the astragalus and the os calcis are the only bones left. The operation is much simpler than Lisfranc's, but its functional results, as has been mentioned, are often unsatisfactory, because the stump easily assumes an equinus position and is then useless for walking and standing. The astragalus is pressed forward more and more by the weight of the body and the contraction of the tendo Achillis. Tenotomy of the latter, which is recommended on this account, does but little to improve the condition. Schede estimates the functionally bad results attending Chopart's operation at nine and a half per cent.

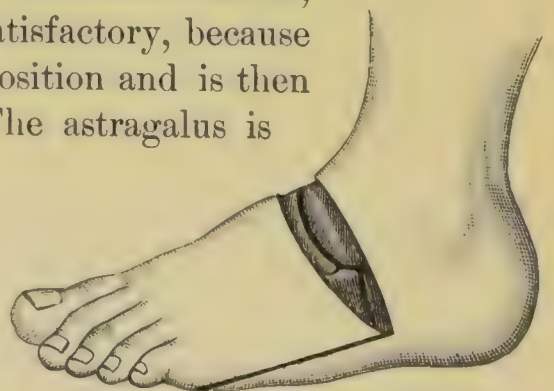


FIG. 930.—Chopart's joint.

Chopart's amputation at the medio-tarsal joint is performed as follows: The tuberosity of the scaphoid on the inner border of the foot

and the tuberosity of the fifth metatarsal bone on the outer border are first marked with the thumb and forefinger. The joint between the astragalus and scaphoid lies about one centimetre behind the former. The two terminal points upon which the fingers have been placed are then joined by an incision over the dorsum of the foot. On the left foot a narrow, medium-sized amputation knife is placed upon the tuberosity of the scaphoid and carried with sawing strokes, cutting all the soft parts to the bone, straight over to the outer border of the foot, about a thumb's breadth behind the tuberosity of the fifth metatarsal bone. The dorsal incision can be made in the opposite direction on the right foot, passing from without inward. We find the medio-tarsal joint (Fig. 930) most easily directly behind the tuberosity of the scaphoid, which can be distinctly felt—that is, on the inner border of the foot. The articular cleft between the cuboid and the os calcis, which runs obliquely backward and downward, lies somewhat posterior to the curved articular line between the head of the astragalus and the scaphoid. Care must be taken, in opening the medio-tarsal joint on the inner border of the foot directly behind the tuberosity of the scaphoid; neither to stray forward into the joint between the scaphoid and the three cuneiform bones nor backward into the ankle joint. When the medio-tarsal joint gapes sufficiently, a rather large amputation knife is inserted behind the articular surfaces of the scaphoid and the cuboid and carried forward with sawing strokes close to the bone, cutting a plantar skin-muscle flap extending nearly to the heads of the metatarsal bones (Fig. 930). The dorsalis pedis artery and the external and internal plantar arteries are then tied. The anatomy of the wound is represented in Fig. 931.

As a means of preventing the above-mentioned equinus position of the Chopart stump, with retraction of the heel and the bad functional results conditioned thereupon, Helferich has recommended opening

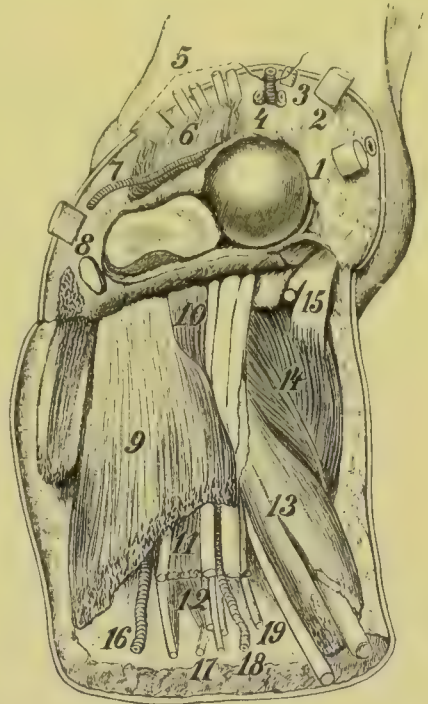


FIG. 931.—Anatomy of the wound after Chopart's amputation: 1, tendon of the tibialis anticus with the internal saphenous vein; 2, extensor hallucis longus; 3, anterior tibial nerve; 4, dorsalis pedis artery with its two veins; 5, tendons of the extensor digitorum communis longus; 6, extensor digitorum communis brevis; 7, tarsal branch of the dorsalis pedis artery; 8, peroneal tendons; 9, adductor hallucis and portions of the interossei; 10, flexor accessorius with the tendon of the flexor longus digitorum; 11, flexor longus digitorum with the lumbricales; 12, flexor brevis digitorum; 13, flexor hallucis brevis; 14, abductor hallucis; 15, tibialis posticus; 16, external plantar artery; 17 and 19, plantar nerves; 18, internal plantar artery.

the astragalo-tibial joint after the completion of the operation, removing the cartilage with a sharp spoon, and immobilizing the joint for the purpose of bringing about ankylosis. To secure a firm union of the plantar fascia, it is sutured to the dorsum of the foot. It is also a good plan to remove the prominence on the anterior lower edge of the os calcis with a chisel or metacarpal saw.

Subastragaloid Amputation of the Foot (De Lignerolles, Textor, Malgaigne, and Farabœuf) is another partial amputation, in which the astragalus alone is left behind. A flap of soft parts is formed from the dorsum and the inner side of the foot. The operation has yielded surprisingly good results.

Malgaigne performed this operation as follows: One incision (Fig. 932, *a b*) begins close above the tuberosity of the os calcis at the inner border of the tendo Achillis, about on a level with its insertion, divides the tendo Achillis, then passes under the external malleolus and over the middle of the cuboid to the dorsum of the foot, and finally runs perpendicularly downward from the anterior border of the scaphoid to the inner side of the metatarsus and as far as the middle point of the sole. The two ends of this first incision are united by a second, which begins at a right angle to the end of the first, runs along the middle of the sole in the direction of the heel, and continues to the beginning of the incision on the inner border of the tendo Achillis (Fig. 932, *c d*). The incisions are made down to the bone throughout. The two flaps are then detached from the bones until both lateral surfaces of the os calcis and the medio-tarsal joint lie exposed. The ankle joint must not be opened, and it is there-

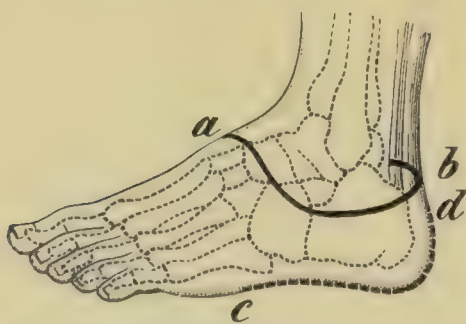


FIG. 932.—Subastragaloid amputation of the foot.

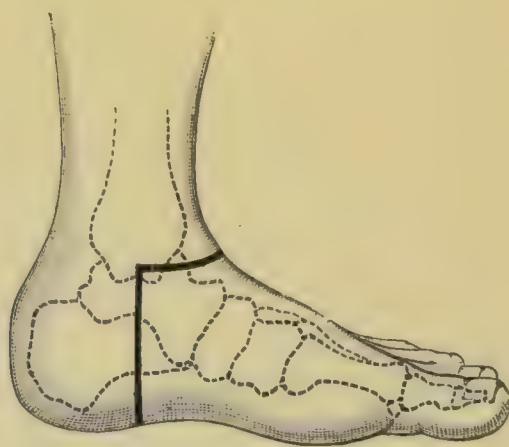


FIG. 933.—Incision for Pirogoff's amputation.

fore necessary to keep sufficiently far away from both malleoli. The medio-tarsal joint is now opened on the inner side of the foot behind the tuberosity of the scaphoid, and the anterior portion of the foot is disarticulated at Chopart's joint. The excision of the os calcis at the astragalo-calcaneum joint is then accomplished by seizing the anterior

extremity of the os calcis with bone forceps, drawing it downward and bringing it into supination and then dividing, by means of incisions with a narrow-bladed knife directed against the bone, the middle fasciculus of the external lateral ligament beneath the external malleolus, the interosseous ligament, and the calcaneo-astragaloid ligament beneath the internal malleolus. The anterior tibial artery is tied on the dorsum of the foot as well as the two branches of the posterior tibial (the external and internal plantar arteries).

Pirogoff's Amputation.—The entire foot is removed by Pirogoff's operation, with the exception of the posterior portion of the os calcis, which is united to the sawn surface of the tibia (Figs. 933 and 934).

The incisions in the soft parts represented in Fig. 933, which are made down to the bone, are executed as follows: The anterior curved incision is first made from the tip of one malleolus to that of

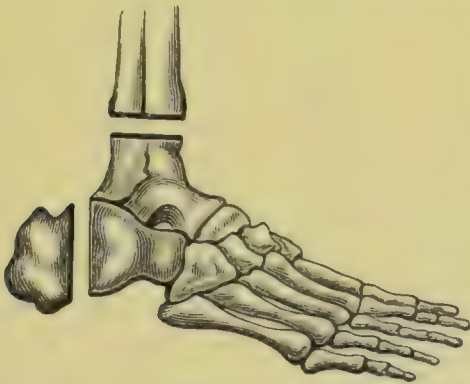


FIG. 934.—Division of the os calcis and the tibia in Pirogoff's amputation.



FIG. 935.—Division of the bone in Pirogoff's amputation as modified by Gunther.

the other over the anterior aspect of the ankle joint, with the foot in plantar flexion, and the so-called stirrup incision is then made, likewise down to the bone throughout, from the two terminal points of the first incision—that is, from each malleolus—extending perpendicularly downward and then transversely across the sole of the foot. The ankle joint is opened on the dorsum of the foot above the articular surface of the astragalus, and the lateral ligaments are severed beneath the two malleoli. The os calcis is laid bare somewhat farther backward, until the sustentaculum tali appears. The saw is placed behind the latter upon the upper surface of the os calcis, and this is sawn through, corresponding to the stirrup incision. Pirogoff sawed off the tuberosity of the os calcis exactly perpendicularly (Fig. 934); but a better plan is to saw it, as Günther recommends, obliquely downward and forward (see Fig. 935). To do this the plantar incision must be made correspondingly oblique. The soft parts covering the tibia and fibula are now dissected up for some distance, subperiosteally it may be, whereby, with a view to the proper nourishment of the heel flap, the posterior

tibial artery behind the internal malleolus must not be wounded. The cuff of soft parts and periosteum is now retracted and the two malleoli and a thin disk of the articular surface of the tibia are sawn off either perpendicularly, according to Pirogoff's method, or obliquely (see Fig. 935), as Günther recommends, so that the surfaces of the tibia and of the os calcis shall fit well together. The anterior tibial artery and the two plantar arteries (external and internal) are tied. After the projecting ends of the tendons have been shortened, the remainder of the os calcis is united to the bones of the leg by suture or by an aseptic steel nail which is driven through the skin of the heel into the bone. The tendo Achillis may be severed close above its insertion and a drainage-tube inserted through the opening in the skin.

Pirogoff's method has been variously modified. Günther proposed, as has been said, to saw the os calcis and the bones of the leg obliquely from behind and above forward and downward (Fig. 935). The bones can then be united more easily and without tenotomy of the tendo Achillis. Günther accordingly makes the stirrup incision, not perpendicularly, but obliquely downward and forward from the malleoli. Le Fort saws the bones as represented in Fig. 936, so as to secure a broader surface for walking. The dorsal incision begins on the right foot, for example, two centimetres below the tip of the external malleolus, and runs with a slight convexity over the line of the mediotarsal joint to a point three centimetres in front of and below the in-

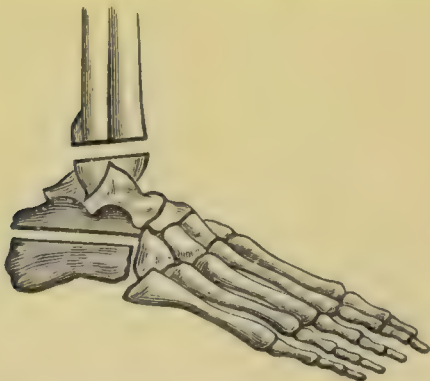


FIG. 936.—Division of the bone in Pirogoff's amputation as modified by Le Fort.

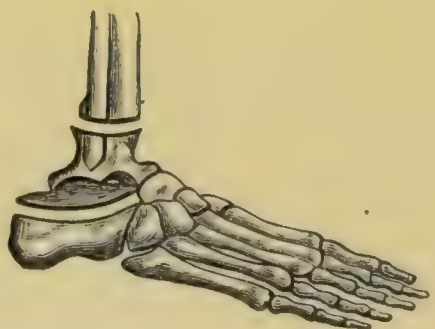


FIG. 937.—Division of the bone in Pirogoff's amputation as modified by Bruns.

ternal malleolus. The plantar incision runs somewhat obliquely forward and downward, much as in Günther's modification. The modification of Le Fort is more difficult of execution. Bruns sawed the os calcis concavely and the bones of the leg convexly (Fig. 937), and in this way likewise secured a very broad surface for walking. Rydygier modified Pirogoff's amputation and substituted it for amputation of the leg in cases of a large ulcer above the ankle by cutting a flap of skin from the entire thickness and length of the sole, reflecting this

upward upon the leg and after dividing the anterior bridge of skin in the middle, using it to cover the ulcer.

If only the inner or outer half of the foot and the os calcis is diseased and the other is still sound, one can, following the method of Tauber and Eiselsberg, utilize the outer or the inner half of the os calcis, which is sawn through sagittally, for covering the sawn surface of the tibia and fibula. W. Rasumowsky recommends for suitable cases of partial disease of the foot an osteoplastic operation based on Tauber's method, which was invented by Isaac Quimby. The skin incision is the same as in Malgaigne's operation (see Fig. 932, page 910); the os calcis is sawn through in a sagittal direction, the edges of the inner fragment that is left are rounded off, and this fragment is fitted into the space between the malleoli which has been made empty by disarticulation of the foot. The cutaneous suture, as in Tauber's method, lies on the outer side. In the same manner the outer or the posterior fragment of the foot that remains may be fitted into the space between the malleoli. This method consists essentially in the substitution of an osteoplastic disarticulation of the foot for the osteoplastic amputation of the leg.

Syme's Amputation is indicated in place of Pirogoff's operation when the posterior portions of the os calcis are also diseased and Pirogoff's operation is no longer practicable. The functional results attending Syme's operation are not so good as those secured by that of Pirogoff. The amputation is performed as follows: The incision in the soft parts is made precisely as in Pirogoff's operation (see Fig. 933, page 910). The ankle joint is then opened here also in front and laterally, and the os calcis is completely enucleated, subperiosteally it may be, from the heel flap. The malleoli and a thin layer of cartilage covering the articular surface of the tibia are sawn off transversely, as in Pirogoff's operation, after the cuff of soft parts has been dissected up from the bone for a sufficient distance. The projecting tendons are here also to be suitably shortened. The malleoli may also be removed with bone-cutting forceps or a metacarpal saw. Great care must be taken in Syme's operation, also, that the posterior tibial artery lying behind the internal malleolus is not wounded. The heel flap is turned up over the bones of the leg, after ligation of the dorsalis pedis and the external and internal plantar arteries, and drained through an opening on the outer side of the tendo Achillis.

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